THE STUDENT.

GROUP OF PANDANUS IN THE DELTA OF THE ZAMBESI RIVER.

EASTERN TROPICAL AFRICA.

From a painting [illegible] by T. Baines, F.R.G.S., in the M[illegible] of the Royal Gardens [illegible]

THE

STUDENT

AND

INTELLECTUAL OBSERVER

OF

SCIENCE, LITERATURE AND ART.

VOLUME I.

ILLUSTRATED WITH PLATES IN COLOURS AND TINTS, AND NUMEROUS ENGRAVINGS ON WOOD

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THE STUDENT,

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FEBRUARY, 1868.

THE SCREW PINE (PANDANUS) AND ITS ALLIES.

BY JOHN R. JACKSON,

Curator, Museum, Royal Gardens, Kew.

(*With a Coloured Plate.*)

IT was Linnæus who first called the Palms the princes of the vegetable kingdom, which opinion has since been endorsed both by botanists, as well as thousands of other admirers of Nature. If, then, the Palms offer so much attraction, both to the scientific and general observer, the Screw Pines must also claim a proportionate share of interest, inasmuch as they partake, on the one hand, somewhat of the habits of the Palms, namely, in their foliage; while they incline to exogens in their manner of branching. They are also peculiar in various other points, which we shall presently explain.

The exact natural position of the Pandanaceæ—that is, the classification as to their relations with other natural families—has been a subject of great difference of opinion amongst many of our eminent botanists. Lindley, writing on this order, says:—"The species of Pandanus and Freycinetia have the aspect of gigantic Bromelias, bearing the flowers of a Sparganium. While there is no analogy with the former in structure, beyond the general appearance of the foliage, the organization of the fructification bears so near a resemblance to the latter, as to have led to the combination of Screw Pines and Typhads by botanists of the first authority. But when we contrast the naked flowers, the compound, highly developed fruit, the spathaceous bracts, the entire embryo, and the arborescent

habit of the former, with the half-glumaceous flowers, the simple fruit, the want of spathaceous bracts, the slit embryo, and the herbaceous, sedgy habit of the latter, it is difficult to withhold our assent from the proposition to separate them. Brown remarks that these have no affinity with palms beyond their arborescent stems. But, on the contrary, Cyclantheæ, which, following Poiteau and others, I formerly adopted, have, with the structure of Pandaneæ proper, the foliage of palms, and are, in reality, a connecting link between the two orders." Further than the opinions here expressed, and as other proofs, also, of the tendency of plants to incline towards two or more orders, may be mentioned the Vegetable Ivory Palm, which, though now acknowledged to be a true palm, was referred, by Endlicher and other authorities, to the Pandanaceæ. *Nipa fruticans* is also another instance of an intermediate plant which we shall have occasion to refer to more fully as we go on.

Screw Pines are natives of tropical regions; are abundant in the islands of the Indian Archipelago, and in most of the tropical islands of the Old World, but rare in America; the section Cyclantheæ, on the contrary, being exclusively confined to that continent.

The Order is divided, as previously stated, into two sections:—I. Pandaneæ, in which the leaves are undivided, or simple, and the flowers naked—that is, without a perianth; and II. Cyclantheæ, where the leaves are flabellate (fan-shaped) or pinnate, and the flowers mostly with a calyx. The first section includes the genera Pandanus, Marquartia, and Freycinetia. The second includes Cyclanthus, Carludovica, and, according to some authorities, Nipa.

Pandanus, of course, is the principal genus of the family, and is characterized by its diæcious flowers—that is, the two sexes being on different plants. The male spadix is composed of numerous small spikes, which are crowded with the small flowers. The female is a round, or sometimes oblong, head, composed of a quantity of small ovaries, very closely packed together, and each of which contains one ovule. The fruits are made up of a number of wedge-shaped drupes, clustered together in the form of a cone, which vary much in size in the different species—some being fully as large as a child's head, while others are scarcely larger than a moderate-sized pine-cone. They vary, also, in shape, being either globular or somewhat oblong. The leaves are for the most part long, narrow, thick, and somewhat leathery, and have, arranged along their edges, as well as along the midrib, a very perfect row of small recurved spines, very sharp, and exceedingly liable to catch the clothing or

flesh of any one coming in contact with them; which, on account of their fineness and light colour making them almost imperceptible, one is very apt to do. These leaves are also remarkable for their uniform spiral arrangement round the axis of the stem, and forming tufts at the ends of the branches, which are arranged at the top of the tall, straight stem, or trunk, in some species, thus giving the plants somewhat the aspect of palms. In other species, however, as will be seen hereafter, the branches are more irregularly given off, the leaves being always in spirals at the ends of the branches. The whole of the naked stems and branches are marked by the scars of old leaves which have fallen off.

The two forms here mentioned are very well shown in the Plate, which is a copy of a painting in oil colours—probably the first landscape ever painted on the Zambesi—by T. Baines, Esq., whose paintings of the Victoria Falls and other African scenery are so well known, and who has kindly given me permission to have the painting copied, the original of which is in the Museum of the Royal Gardens, Kew. I am also indebted to Mr. Baines for the following information as to the locality where the sketch was made:—Some miles from the mouth of the Zambesi, as the mangroves (which have performed their office in converting the accumulating shoals into land capable of bearing a superior vegetation) begin to be supplanted by other trees, the most striking feature in the landscape is the tall Pandanus, which towers above the brush that skirts the various channels of the delta, and in the distance especially, when thickly draped with creeping plants, presents the appearance sometimes of poplar groves, and sometimes of village spires; it seems to begin where the mangrove—*i. e.*, the kind which forms the advanced guard in reclaiming the land from the sea—begins to cease, and where palms of various kinds—dwarf fan palm, wild date, Doum palm, zamias, a kind of Strychnos (*Brehmia spinosa?*), bearing an orange-shaped fruit, large flowering Hibiscus, and occasional cocoa-nuts—begin. Some of these channels are so narrow, that in passing through, the vessel would brush the reeds on both sides, while the main streams would be several hundred yards in width. The specimens shown in the sketch were situate in a perfect tangle of old mangroves, with their aërial roots and luxurious vegetation overgrowing them, so as to conceal and render more precarious the treacherous footway over which we have to pick our way. The tree was covered with convolvulus, and was exceedingly beautiful. This was within the tidal influence, and the stream would be brackish at high water, or fresh when the volume

of the river was sufficient to overpower the tide. These Pandani did not appear to extend far beyond where the river ceased to be brackish.

As many as thirty species of Pandanus have been enumerated. The chandelier tree (*P. candelabrum*), however, is perhaps one of the most striking in appearance of all the species. The branches spread out all round the trunk, bending gracefully downwards, and the ends again inclining upwards, where they are crowned with tho tuft of bright green leaves. This arrangement is shown (as well as it can be in so small a sketch) in the trees at the left hand of the plate. This species, like some of its fellows of large or tree-like growth, is provided by nature with numerous aërial roots, as may be seen in foremost tree in the Plate. These roots are thrown out all round tho stem, and at irregular intervals from each other—sometimes a group of two or three being so close together as to appear almost united, and at other times a solitary one may be seen branching conspicuously by itself. They are usually most numerous near the ground, and are frequently so thick as to completely obscure the original trunk, but they are by no means confined to the lower part of the trunk. At a distance of some feet from the ground they may be seen either breaking through the epidermis or bark, or hanging down, ready to bury themselves in the soil. A full-grown Pandanus, so supported, has about its lower extremities somewhat the appearance of a mangrove-tree; the aërial roots of the latter, however, branch and curve in a much more irregular manner, which is the nature of dicotyledonous trees to do, while in the families allied to the Screw Pines the contrary is the case. The tips or spongioles of these aërial roots, as they hang from the trunks, are protected by thin woody caps, which fall off or decay when the roots touch the ground. The fruit of *Pandanus candelábrum* is nearly round, and is composed of a series of sub-compressed, ovate, angular, drupaceous nuts or seeds, having an exceedingly hard and bone-like centre, with a stiff fibrous coating, which, when fresh, is covered with pulpy or fleshy matter. The shape and appearance of the fruit is not unlike the bread-fruit; and if it were more elongated, it would much resemble a pine-apple, except in colour, being mostly of a dark green, but yellowish towards the lower part; the apex of each of the drupes is crowned with from four to six brownish sessile stigmas. *Pandanus odoratissimus, L. fil*, is, perhaps, one of the most useful species, in an economic point of view. It is a plant some ten, twelve, or more feet high, with spreading, irregular branches, and closely imbricated

leaves, arranged in three spiral rows round the ends of the branches. It grows in the islands of the Pacific Ocean, China, and the East Indies, being common along the banks of the canals and back-waters of Travancore, where it is planted for the purpose of binding the soil. The long leaves are full of tough fibres, which are used for making cordage of various thicknesses, as well as for making hunting-nets, and the drag-ropes of fishing-nets. Matting of all descriptions is likewise made from them. Some of the sleeping-mats, which are dyed or stained various colours, are fine specimens of native plaiting. The leaves are likewise used to make umbrellas, and they are said to furnish an excellent material for paper-making.

The fibre from the leaves is commonly used in Tinnivelly, when mixed with flax, for making ropes. The aërial roots are applied to a variety of purposes in India. Manufactories exist in some localities where hats, baskets, mats, etc., are made from them. On account of their light spongy nature, they make excellent stoppers for bottles in lieu of cork, and the more fibrous part, when beaten out and the pulp removed, is used for brushes for whitewashing, painting, etc. The roots are used medicinally by the native practitioners, and an oil prepared from them has the repute of being a cure for rheumatism. The flowers are odoriferous, as the specific name indicates. Besides the numerous uses already mentioned, the inner or pulpy part of the drupes is eaten as an article of food in times of scarcity. In some parts of N. Australia, indeed, the fleshy drupes of the Pandani are commonly eaten, being held in the mouth and sucked until the fleshy portion is consumed. In the Society Islands the women make very beautiful mats of the leaves, which are first prepared by burying them in the sand near the sea for about a month; this makes them soft, they are then carefully scraped with a shell which removes all irregularities, leaving that portion of the leaf intended for use fine and soft; the more care exercised in this preparation the finer and softer are the mats. After being thus prepared, the leaves are drawn across the edge of a shell previously notched or toothed at regular intervals, by which means they are divided into long narrow strips of equal width and are ready for plaiting.

P. utilis, Bor., as its name implies, is another most useful species. Most of us have some acquaintance with the leaves of this plant. The sacks or bags in which the Mauritius sugar is imported are made from them, and these bags, after discharging their principal duty in bringing sugar to this country, are sold to the fishmongers, who use them for making bags or baskets for packing fish. The plant is a very common one in the Mauritius, and, further than

this, is also largely cultivated there for the sake of its leaves for bag-making.

Mr. Ellis, in his "Visits to Madagascar," says:—

"The Pandanus exhibits a form of growth peculiar to the vegetation of the sea shore in many tropical regions. It thrives well in pure sand near the water's edge. It is also an exceedingly useful tree. The trunk is durable, and is employed in the structure and fitting of native canoes. The leaves in the South Sea Islands, make excellent thatch, and the fruit or nuts are baked and the kernels eaten. In Madagascar the leaves are used chiefly for covering packages to exclude rain during transit from the coast to the interior. It is extensively cultivated in Mauritius, and its leaves used for making bags, large quantities of which are brought from the Seychelle Islands, and all the sugar produced in Mauritius is exported in bags made from the leaves of this singularly growing but useful tree."

Referring to other species growing in Madagascar, the same writer continues:—"I had seen nothing either in the Mauritius or Polynesia resembling them, especially one kind seldom attaining above ten or twelve feet in height, having a number of leaves in the centre of the crown, apparently glued or stuck together at their extremities, giving to the centre, or crown, a singular form; while the disentangled leaves that stretched out horizontally or hung down parallel with the stem, seemed very much like the leaves with which the Chinese line their tea-chests." "Another species of Pandanus was to me equally new and remarkable. The stem of this was straight as that of a fir-tree, and the branches horizontal with feathery tips of flag or short ribbon-formed leaves. The tree was frequently forty or fifty feet high, crowned with an upright plume, and at a distance might have been mistaken for a larch, but for its stiff and formal growth. I did not see it near the shore, but amongst the low wet places inland."

The leaves of several other species are used by the natives in the countries where they grow for plaiting, for making mats, etc. Freycinetia is a genus composed chiefly of climbing trees, and, like the Pandani are natives of tropical countries, being found in the Sandwich Islands, New Zealand, the Islands of the Indian Archipelago, Norfolk Island, etc. Botanically, Freycinetia is chiefly distinguished from Pandanus by the stamens of the female flowers being abortive, and the division of the ovary by three parietal placentæ, the male spadix unbranched, and the fruit composed of a number of fleshy drupes apparently merged into one mass. The Freycinetias abound

in swampy forests, many of them clinging to trees and imparting to the trunks a peculiar appearance by their long and narrow leaves. These leaves are used for similar purposes to those of the Pandani, namely for plaiting into mats, etc. When dried and properly prepared they are exceedingly fine as regards the texture, and very white in colour.

Carludovica is a small genus, some species of which, like the Freycinetias, are climbing or epiphytal on the trunk of trees, and have aërial roots which hang down like so many ropes or cords, others are terrestrial, growing in dense thickets. They are almost exclusively confined to the tropical part of South America; one species, however, *C. Plumieri*, Kth., being found in Dominica and Trinidad, and two other species, in the French West Indian Islands. The flowers, which are monœcious, are beautifully arranged in squares closely packed together and forming a cylindrical spike or spadix. Each female flower is in the centre of one of these squares, and is surrounded by the males, four in number. The stigmas are sessile upon these small square ovaries or berries, which impart to the spike a very uniform pattern.

Carludovica palmata, R. et P., is the most valuable and interesting of all the species; it is the plant from whose leaves the celebrated Panama hats are made. Dr. Seemann, who has travelled much in South America, has given such an excellent account of this plant and its uses, that we cannot do better than give it entire. He says:—"The leaves are from six to fourteen feet high, and their lamina about four feet across. The spathe appears towards the end of the dry season, in February and March. In the Isthmus, the plant is called *Portorico*, and also *Jipijapa*, but the latter appellation is most common, and is diffused all along the coast as far as Peru and Chili; while in Ecuador a whole district derives its name from it. The Jipijapa is common in Panama and Darien, especially in half shady places; but its geographical range is by no means confined to them. It is found all along the western shores of New Grenada and Ecuador; and I have noticed it even at Salango, where, however, it seems to reach its most southern limit, thus extending over twelve degrees of latitude, from the tenth N. to the second S. The Jipijapa, or Panama hats, are principally manufactured in Veraguas and Western Panama; not all, however, known in commerce by that name are plaited in the Isthmus; by far the greater proportion is made at Manta, Monte Christi, and other parts of Ecuador. The hats are worn almost in the whole American continent and the West Indies, and would probably be

equally used in Europe, did not their high price, varying from two to 150 dollars, prevent their importation. They are distinguished from all others by consisting only of a single piece, and by their lightness and flexibility. They may be rolled up and put into the pocket without injury. In the rainy season they are apt to get black, but by washing them with soap and water, besmearing them with lime-juice or any other acid, and exposing them to the sun, their whiteness is easily restored. So little is known about these hats, that it may not be deemed out of place to insert here a notice of their manufacture. The 'straw,' previous to plaiting, has to go through several processes. The leaves are gathered before they unfold, all their ribs and coarser veins removed, and the rest, without being separated from the base of the leaf, is reduced to shreds. After having been put in the sun for a day, and tied into a knot, the straw is immersed in boiling water until it becomes white. It is then hung up in a shady place, and subsequently bleached for two or three days. The straw is now ready for use, and in this state sent to different places, especially to Peru, where the Indians manufacture from it those beautiful cigar cases, which fetch sometimes more than £6 a-piece. The plaiting of the hats is very troublesome. It commences at the crown, and finishes at the brim. They are made on a block, which is placed upon the knees, and requires to be constantly pressed with the breast. According to their quality, more or less time is occupied in their completion; the coarser ones may be finished in two or three days, the finest take as many months. The best times for plaiting are the morning hours and the rainy season, when the air is moist; in the middle of the day and in dry, clear weather, the straw is apt to break, which, when the hat is finished, is betrayed by knots, and much diminishes the value."

Though the plaiting of these hats is so exceedingly fine, irrespective of the high price, some modification would be required in the ordinary shape of a Panama hat for them to be more generally worn in this part of Europe.

At the commencement of this paper, in speaking of the division of the order into two sections, we included the genus Nipa, in the second division, as a very doubtful member, and promised to refer to it more fully hereafter. We are not sure, however, whether it should be included at all. The question as to its proper position being still an undecided one, the first authorities themselves being doubtful whether to put it with Palms or Pandanus. The genus is represented by only one species, *Nipa fruticans*, Humb. It abounds

in the salt marshes of the islands and coasts of the Indian Ocean, where it covers thousands of acres. It is a low-growing, stemless plant, with pinnatisect, feathery leaves, often more than twenty feet long. The flowers are monœcious—that is, with the males and females on the same plant, and they are enclosed in a spathe similar to that of a palm. The fruits are composed of a number of one-seeded drupes, forming large round bunches quite the size of a man's head; the kernels or seeds of which are eaten. In the Philippine Islands and Borneo, a kind of toddy is obtained from the spathe, from which sugar, syrup, and a strong spirit is manufactured. The leaves are commonly used for thatching houses, and are said to be very durable, large quantities of them are sent northward from the provinces of Tenasserim for this purpose. They also yield a large quantity of salt when burnt. The fruits are found floating about in the Indian Ocean, and indeed are often carried to far greater distances. One specimen, for instance, in the Museum at Kew, was picked up on the coast at Freemantle, Western Australia. Dr. Hooker, in his "Himalayan Journals," says they were frequently tossed up by the paddles of the steamers at the mouths of the Ganges.

Besides the botanical interest of this plant, it is, as Dr. Hooker says, of great interest to the geologist from the nuts of a similar plant, abounding in the tertiary formations at the mouth of the Thames, and having floated about there in as great profusion as it does in the Indian Seas at the present time, till found deep in the silt and mud that now forms the Island of Sheppey.

THE SILKWORM DELUSION.

BY SHIRLEY HIBBERD.

VERY much has been written on the possibility of cultivating silk in England, and it is an article of popular belief that it *might* be done and leave a fair margin of profit (perhaps more) as a commercial undertaking. There are several books treating of the Ailanthus silkworm, which feeds upon a hardy tree and requires very little care, and produces a great quantity of silk which is wonderful in texture, and in value, therefore——but let us wait to ascertain its value, till we see it in the market.

The Oak-tree silkworm, too, is offered us as admirably adapted for silk production in this climate; and, as we have an abundance of oak-trees, what is there to hinder us from converting woods and coppices into silk districts? Well, it is time to ask seriously, can it be done? and as respects experiences acquired in certain quarters of this tight little isle, I am here to-day to pronounce the whole affair a mockery, a delusion, and a snare. For the sake of conciseness, decisiveness, and some other considerations of less consequence to the reader, than to the persons engaged in the silkworm experiences, I shall put myself in an ideal position, and speak as having had a hand and a purse in this business, so as to avoid referring to a mysterious "they" in any part of the story, which I assure you is true in every jot and tittle, bar the *personnel*, which really cannot matter.

Well, I was fired with enthusiasm about this silkworm business, and believed that therein were the germs of an undeveloped industry to which I was bound in conscience and patriotism to play the part of pioneer. I went to work in earnest with ten thousand pounds at command, and a small stock of knowledge respecting the history and habits of *Attacus cynthia,* alias *Bombyx cynthia,* and the tree the insect loves, *Ailantus glandulosus*. The first step was to purchase an estate of a thousand acres, more or less, in a district where land and labour were low priced, and the climate is of a more equable nature than in almost any other part of Great Britain. We then dreamed of some day changing the name of Broadbury to Attacacia, or Sericaria, and, at all events, we took serious measures for locating on the spot a sufficient population for the industry that was to be developed, and we have the plan of a village (on paper) which really must have been built had the two A's (viz. the Attacus and Ailant)

proved as faithful to us as we were devoted to them. Well, it appeared that we had the right sort of climate, and the right sort of soil, and we started fair by laying down four hundred acres in Ailant. There were many difficulties to be overcome. We were much troubled to obtain seed of the tree, but at last M. Vilmorin, of Paris, helped us out, and we purchased many tons of seed of him. A still greater trouble occurred in respect of worms, but we got a few bushels of eggs at last, and Ailanti-culture was commenced with a prospect as bright as I had ever seen it, even in my dreams.

The routine of culture has been told in all the books, the writers whereof have learnt it by help of two or three trees and a few hundred worms. Our operations were on a somewhat larger scale than we have read of in the books. The land was drained, ploughed, and cleaned. The seed was drilled in rows two feet apart, and, generally speaking, made a good start and grew into trees six inches high the first season. In 1861 we put out worms on about one hundred acres. We learnt to deal with the insect thus:—A number of tiffany sheds were built; the cocoons, being all strung on cords like necklaces for savages, were suspended in these sheds, and in due time the moths came out and completed their life's career under canvas. We tried glass houses, which were useful all winter, but in spring the tiffany answered best because being cool: the moths were not hastened into activity until the season was sufficiently advanced for them. It is almost a sufficient compensation for the loss of a few thousands in this business to call to mind the glorious appearance of a large clean tiffany tent planted full of Ailant bushes two or three feet high and crowded with the moths in their first days of transformed life and earnest courtship. It is but a short time they last, and then the cultivator considers what his gains are in empty cocoons and eggs. We shall come to the cocoon business presently; let us now consider about the eggs. After numerous experiments we found the only safe way to deal with these was to leave them alone in the coolest place that could be found for them, and where they were screened from sunshine and from wet. By keeping them cool the worms are not hatched until the trees bear leaves to feed them. If they are kept too warm they hatch into a world where their fate is starvation; and in spite of the utmost care this will sometimes happen, and is one of the greatest disasters incidental to the business. Our plan has always been to allow the young worms to spread about amongst the trees under cover as the season advances, and as they acquire enlarged appetites they are transferred by women and children to the open plantations, where they quickly

fix themselves on the undersides of the leaves, and hold as firmly there as if integral parts of the leaves themselves. Thus I have endeavoured, by the help of faithful co-workers and constant observation, to adapt this culture to English soil, and it is time the reader knew something of the results.

In 1861 we had a good year, and we were in good spirits. The trees had made a free growth, and the worms throve; cocoons were abundant. Now, the value of a cocoon is the fundamental item in the scheme of accounts of a silkworm farm. Know, then, that the cocoon of this Attacus (or Bombyx) does not yield a continuous thread. From the cocoon of the mulberry-worm, *Bombyx mori*, we may wind *a continuous thread* 1000 to 2000 yards in length; but from the cocoon of the Ailant worm *you cannot wind a continuous thread at all*. The cocoon is in form elliptical, pointed at each end, and looks very much like a dirty brown nut. Hundreds of ropes of them dangle about and around me as I write this, mockeries of my sacrifice, my blighted hopes, my wasted enthusiasm. You cannot wind the silk, therefore it must be carded, just as, in the cotton manufacture, carding is performed in order to arrange the fibres. Well, when it is carded, its value is such that it stands *lowest in the scale of all known silks that come into the market*. It is weak, it lacks lustre, IT IS TRASH! Yet, in spite of these facts, the year 1861 was so good that we saw, through the returns, our way pretty clearly to realize a profit of ten shillings per acre, after allowing for all outgoings, and ten per cent. on the cost of the land. When I had fully made up my mind to this, I began to enlarge the operations. The year 1862 was a good year, and the profits were about eight shillings per acre. The year 1863 was a bad year, for the trees came into leaf late, myriads of worms were hatched too early to be fed, and perished. We now began to discover that the practice of cutting down the trees annually to keep them dwarf, was likely to kill them in the end. It will be understood that the trees must not be allowed to get up higher than four or five feet, because although the worms hold fast, and insectivorous birds do not hunt them with great pertinacity, yet, if the trees were tall, the wind and the birds together would make considerable havoc. Yes, frequent cutting down reduces the vigour of the tree, and we can point to rows that have been left uncut and are full of vigour, while broad plantations that have been cut over annually are nearly killed out. The year 1864 was worse than '63, and this in spite of the continual enlargement of our operations and the acquisition of experience therefrom. The winter killed a great many trees, and the spring was cold.

The profits this year averaged about two shillings per acre. On the same land we were deriving £20 per acre profit by the cultivation of potatoes; and I then resolved to contract operations in silk, and enlarge in the way of corn and roots. The year 1864 was a good year; but a good year at this sort of work means a dedication of the land to the formation of a high road to the workhouse, for at the best the profits are nothing, the silk is trash, and you cannot be sure of obtaining a handful. I am positively happy—it may be a fiendish happiness, but I am happy to say that 1865 gave the silk business at Broadbury its death-blow. There came a smart frost after the trees were in leaf, and the worms were active in feeding. The worms were instantly *non est*, and the trees were black as if burnt. Then we resolved to restore the silk trade to its ancient and proper place in England, the realm of toys; and 200 acres of Ailant were ploughed up and sown with roots, and there was a real and good return for the outlay in the place of a mockery, a delusion, and a snare. This change of tactics was resolved on none too soon, for 1867 would have been one of the worst years in this melancholy history, for the winter killed many of the cut-down trees, the bitter frost in the middle of May afforded a gentle hint of the dangerous nature of this enterprise; and the prevailing cold, all the season through, even to the time of the spinning, would have crushed us, had we not already taken warning and given more attention to grain and cattle food, than to the wretched Ailantus. I have about twenty acres of the delusion left, and so much I propose to keep as an example and a warning. Besides, I am a little weak on the subject of hobbies, and cannot quite obliterate the worm from Broadbury, though it has cost me so much and so basely deceived me. The thousands of pounds invested in the silk business will not all be lost, for in place of Ailant we are establishing a great meat factory; and possibly, except the silkworm had coaxed me into these parts, the lands we are now tilling with advantage to ourselves and the community, might have remained in the state of waste in which I found them, when I made a bold bid for them in the capacity of the first producer of silk in England.

THE ROCKY MOUNTAIN GOAT.

BY JOHN KEAST LORD, F.Z.S.

(*With a Coloured Plate.*)

I KNOW of no animal so wild, solitary, and unsocial in its habits as the Rocky Mountain Goat. I first saw it in its native wilds, on the summit of the Rocky Mountains, near the Kootanie Pass. It was about midsummer, and, at that period of the year, the higher levels of the Rocky and Cascade Mountains are most delightful and enjoyable localities. The sun has by this time partially cleared away the winter's mantle of snow, and patches of bright green herbage spread out like well-kept lawns, stretching away from the bases of the glaciers, and down the slopes of the rocky cliffs, and wherever the regular drip of the melting ice and snow keeps up a kind of continual irrigation. Hardy flowers of semi-Alpine type overspread the moss-covered knolls, or push their bright corollas from out the clefts and chasms of the splintered rocks. The only tree that flourishes at all at this altitude is the *Pinus contorta*, and even that has a half-starved, stunted appearance. Everywhere the eye rests on huge piles of snow, that never entirely melt, but keep everything beneath them damp by the slow but steady slush of the thaw; and one might easily imagine the little oases of green discernible amid the heaped snow to be islands in a frozen sea.

Before, behind, to the right hand and to the left, immense pinnacles of rock seem to tower up into the very clouds. If you climb up as high as the snow and ice will permit, and scan the surrounding scene with a telescope, nothing is to be seen from sky-line to sky-line but one vast expanse of mountains of varying height and shape. Well may you pause, and wonder what power could have been adequate to pile up this great central axis of elevation. The stupendous immensity of everything round about seems to overwhelm and, if I may so say, absorb you. You feel like a mere atom amidst these, the grandest rocks in the world; and the more you ponder on this marvellous evidence of God's might and power, the more humbled and insignificant you feel in your own estimation.

Sitting down one bright, sunny day, half-dreamily contemplating the description of scene I have endeavoured to describe—for I felt very tired, from having had a tough and tedious climb to reach a ledge of rocks, from which I could, if I chose, without rising from a sitting posture, dip up the water that flowed, on the one side into the Atlantic, and on the other into the Pacific Oceans—

I was suddenly startled from my reverie by hearing some stones rattle down from the rocks above where I sat. Looking in the direction from whence the sound came, I espied a splendid specimen of the Rocky Mountain Goat. He was peering curiously at me, as though contemplating some strange apparition, quite new to his haunts. I thought I had never before contemplated so picturesque a sight as that wonderful animal perched upon a mere ledge of rock. A long, snow-white, shaggy coat hung down nearly to his hoofs. His mild but lustrous eye had a melancholy expression, which, together with his venerable beard and well-haired face, gave him a kind of human countenance; and one need not have stretched his fancy very much to have imagined that Hrymir, the Ice Giant, and no one else, had suddenly put in an appearance to know why a mortal invaded his domains. No thought of doing the goat any injury entered into my head just then. My daily hopes since I had been on the mountains were thus suddenly and unexpectedly realized. I could, and did for the first time, gaze upon a Rocky Mountain Goat amidst his native rocks. In nothing did this animal, to my mind, resemble a typical goat; but everything about it bore a much greater resemblance to the antelope tribe. The horns, the shape of the body, the peculiarity of coat, the slender but firmly-set limbs, were in nothing suggestive of a true goat. Having had a good look at him, I turned very gently round to place myself into a better position, so as to bring my field-glass to bear upon him. It was enough to warn the crafty beast that probably danger lurked in the stranger. With one bound he cleared a wide chasm intervening between the crag on which he stood and the adjoining pinnacle of rock, and, quick as a swallow, vanished from my sight as mysteriously as he had come.

Now that I discovered that goats were near my camping-ground, I spared neither time nor labour to watch their habits, and to obtain specimens. Very often I have tracked a small herd of them up some steep incline or rocky talus, and then have lost all further trace. Wandering on, half in hope and half in despair, suddenly I have espied a tiny party of goats, perhaps a patriarch and his three or four wives, and their children, slowly making their way round some splintered angle in the rocks; and as one by one they come in sight, following the male, who always leads, so they marched along in single file, deliberately, and, to all appearance, with the utmost carelessness, upon a narrow ledge of rock, where we would suppose a cat would be puzzled to find a secure footing—

above them a vertical wall of smooth rock, below them a precipice, perhaps hundreds of feet in depth. Fire at, or otherwise frighten them, and they gallop along this narrow footway as safely as they walked; and when any chasm had to be crossed, it was perfectly wonderful to watch the precision and certainty with which they, one after another, lighted upon the same spot, perching, more like birds than hard-hoofed quadrupeds, upon the smallest available projections. I very soon obtained some specimens of these most interesting animals, and here will be the best place to describe them. I am quite convinced that the so-styled goat of the Rocky Mountains is, in every one of its essential features and affinities, an antelope. It has nothing in common with animals of the domestic goat type, save and except such general characters as more or less belong to all ruminants related to it. In the jetty black, highly-polished, slender, conical, and slightly curved horns, the type of the chamois is most conspicuous; in other particulars it approximates the prongbuck.

The specific characteristics may be summed up as follows:—Horns small and symmetrical, conical, black, and slightly curved in a backward direction, the points sharp, and yellowish in colour, the base regularly ringed; nose ovine, and somewhat hairy; tear-bag and mouffle none; nostrils black; hoofs black; colour entirely white. The coat, which is remarkably thick, is composed of two classes of hair, the one extremely long and rather coarse, beneath which is a dense covering or fleece of wool, of the very finest class, quite as delicate in fibre and texture as that of the famed goat of Cashmere, from whose fleece such costly shawls are manufactured. There are rudimentary false hoofs, and a long pendant tuft of hair graces the chin. The size of the full-grown animal is rather larger than the average size of a domestic sheep. The outer covering of hair is extremely long, and hangs down all over the body, tail, and upper part of the legs, reminding one very much of the merino sheep: this is most abundant on the shoulder, neck, back, and thighs. The beard which hangs from the chin seems to be continued down the throat, and to dangle in the same way from the chest between the fore legs. The sexes are pretty much alike, only that in the male the horns are rather more developed, and the beard and outer coat longer. The kids are the prettiest little things imaginable; they were running with their mothers at the time I first saw them, which was early in July; so that I should imagine the period for producing their young would be somewhere about the end of May, or the beginning of June. I never saw but one female with two kids at her side; hence, I am

E ROCKY MOUNTAIN GOAT.

Ap...cerus m... tanus (...)

disposed to think that one kid is the usual number produced at a birth. I have often watched the little fellows at play. Choosing some rounded knoll, they seemed to go in for a game of "I keep castle." One, having possession of the summit, tried his best to beat off and keep down all besiegers, until another, taking him at a disadvantage, butted him off, and then held his right of territory, until displaced himself by some other adventurous rival. Nothing could exceed the agile, springy, elastic bounds of these little kids, as they frisked and gambolled upon the grassy sward. I do not think these goats (I shall continue to call them goats for convenience' sake) ever descend into the valleys; but when the winter snows cover up the higher zones of the mountains, they come down only to the verge of the snow line, and there somehow contrive to scrape up a scanty livelihood, until the summer's sun restores to them their favourite pasturing ground.

Few animals—I do not even except the big horn (*Ovis montana*), or the prongbuck (*Antilocapra Americana*)—are more difficult to hunt than are Rocky Mountain Goats. Tenanting, as they do, the loftiest ridges and pinnacles of the mountains, which often attain an altitude of ten or fifteen thousand feet above the sea-level, climbing after and following these goats entails upon the hunter an amount of labour and fatigue that is likely to exhaust him completely before he really begins his hunt. Moreover, the difficulties are greatly multiplied by the extreme caution and wariness of the animals themselves.

Their senses of smell and hearing are wonderfully acute, and to approach them one has to scramble up the face of nearly vertical cliffs of rock from ledge to ledge, and twist like an eel round sharp angles and ragged projections, where a slip would most likely end in being hopelessly smashed in the depths below. Getting the "wind" of the goats under such difficulties is by no means as easy a task as it is on the plains and in the wooded valleys. Hence it very often happens, when you have toiled long and wearily after a herd of goats, that they suddenly get your "wind," and are gone for ever, when, figuratively speaking, you imagined you had your hand upon them. More than once I have climbed and climbed until my arms and legs ached again, and, when my labours were nearly being crowned with success, I have, by accident, displaced a few stones, which have gone rattling down from crag to crag, a warning and danger signal by which the goats at once profited, much to my chagrin and discomfort. I did, however, obtain some fine specimens, one or two of which are

now in the British Museum, and others, as trophies, are spread out upon the floors in some of the rooms in my residence, and very admirable mats they make.

If space allowed, I could relate some very sensational adventures and escapades that I have had whilst hunting the Rocky Mountain Goat. Its flesh I do not at all admire; it has a strong, rank flavour, and is generally as tough as a moccassin; even the kid's flesh is not exempt from this disagreeable taint. Their food consists of the grasses that are commonly found at great altitudes, together with lichens, mosses, and the young fronds of the *Pinus contorta*. The mountain goat has rather an extensive range, though, so far as I know, it is only found in North and North-Western America. It is common on all the higher portions of the Northern Rocky Mountains—Cascade, Coast, and Olympian ranges. I have likewise met with it in considerable abundance upon the more elevated peaks and crests of the mountains in Washington territory. It has also been obtained near Fort Benton, and it extends its range in a northerly direction to latitude 65° N. A very favourite haunt of this goat is on Mount Rainer, one of the most lofty of the coast range of mountains. The Indians also obtain a great many from the mountains near Fort Simpson, and on the hills near Upper Nesqually.

As an article of food, the North-Western Indians care very little about the flesh of the mountain goat, and were it only valuable for edible purposes, it would be seldom sought after by the hunter; neither is its skin of any material value to the fur trader. The Hudson's Bay Company take a few of the better class of goat-skins from the Indian fur-trappers, but pay only a very meagre price for them. It is worthy of remark, *en passant*, that at the Hudson Bay Company's March sale for furs for the year 1867, Rocky Mountain Goat-skins, although of unusually fine staple, realized only about a shilling per skin, not a tenth part as much as they made in the years 1864-5; and this falling off in value is thus accounted for:—During the previous years, it was the fashion with the ladies to use muffs, tippets, etc., made from the long black hair of an African monkey. The dyed hair of the Rocky Mountain Goat exactly corresponds with that obtained from "Jacko," and as it could be purchased for a considerably smaller sum, the demand was great for it; and hence the increased price it fetched at the auction. Now monkey-skin garments are not in vogue, the goats' hair employed to imitate it is not required, and accordingly the price has receded to a mere nothing. It is not a little remarkable that the employment of this jacket of a tropical animal should have a

direct influence upon the value of one mainly confined to high northern latitudes.

To the Indians, however, the skin of the mountain goat is, or rather once was, of inestimable value. Prior to the Hudson's Bay Company establishing their trading depôts for the acquirement of furs throughout North and North-West America, the savages west of the Rocky Mountains were in the habit of making a rude description of blanket or rug from the fleece of the mountain-goat. This art, to a great extent, ceased when the English blanket was introduced by the Hudson's Bay Company, and was given in exchange for furs of different kinds. I obtained several rugs of the original manufacture whilst naturalist to the British North-American Boundary Commission, and I also procured the apparatus with which the aborigines of British Columbia and Vancouver Island spun the softer wool into yarn. I likewise got hold of the rude loom with which they afterwards wove the yarn into a rough but efficient blanket. These, together with specimens of the yarn and woven blankets, are deposited, and can be seen, in the ethnographical department of the British Museum.

In conjunction with the fleece of the goat, the hair obtained from a peculiar breed of long-haired white dog was likewise frequently employed in spinning the yarn. The hair was plucked from these wretched dogs at a particular season of the year, and the tortures they afterwards endured from the mosquitoes was something terrible to contemplate. In some of these curious blankets I obtained of native makers, duck and goose feathers are worked in with the goats' wool and dogs' hair. It seems to me that this art of weaving, which was clearly known to the aborigines long before we knew of their having had any intercourse with civilized people, opens up some extremely curious and interesting queries. Whence did those tribes of savages, living so far beyond the range o civilization, obtain their knowledge of the art of weaving? There can be no question that the North-Western American Indians were familiar with the art before we have any tradition of their having had any opportunity of learning it from civilized people. And not only the art of weaving, but the science of dyeing with different colours such materials as they employed, was also known and practised by them. I have specimens of mats and rugs, showing carefully-designed coloured patterns. Now, the first question that presents itself for consideration is, how and whence did these savages obtain the long-haired white dog? The dog is now extinct, or nearly so—its use having ceased with the introduction of English

blankets. I have tried to trace its history, and I may state what I have discovered in this article, as the hair of the dog and of the mountain-goat were jointly used in the manufacture of blankets.

This long-haired dog was possessed only by a few tribes of Indians, who inhabited the N.W. coast. The dogs were scrupulously kept on islands, in order to prevent any chance of their escaping; and I feel confident I am right in stating that these dogs differ in every specific detail from all the other breeds of dogs belonging to either the coast or inland savages. I am disposed to think that this long-haired dog was originally imported into North-Western America from Japan; and I am the more confirmed in this belief, from the statement of a friend of mine who is familiar with Japan. He tells me the Japanese have a small dog clothed with long white hair, closely analogous to the dog which was a few years ago kept and plucked by the North-West Indians for rug-making. There can be little doubt that the Japanese visited the coast of North-West America long prior to any other civilized people. Whether such visitors were accidentally wrecked, or whether they designedly landed in order to trade with the aborigines, is a matter not by any means easy to trace or determine.

Traditions are still existent amongst the savages who reside near the mouth of the Columbia River, of strangers having been once amongst them a very long time before they had ever seen Europeans; and what is yet more confirmatory of the supposition that these were Japanese people is the fact, that words clearly of Japanese origin are still employed in the jargon called "Chinook," commonly spoken along the coast. If I am right in this surmise, then I can see nothing very extraordinary in dogs having been brought on board the vessel, or in their subsequently becoming the property of the natives, who would be quite sharp enough to see that an animal with such a long, shaggy coat would be of great value to them. My idea is, that the art of weaving was imported at the same time as the dogs, and that the savages, on discovering how the hair of the dog could be made into comfortable coverings, at once sought out the mountain goat, because its hair was so exactly like that of the dog, served the same purposes on being woven, and was to be obtained in unlimited abundance.

That the dog was not indigenous I am quite positive. Endless varieties of dogs are at present called "Indian dogs"—nearly all of them, however, where the aborigines have been trading with whites, are either crosses with the native dog, or curs of various kinds, which have from time to time been imported by emigrants

or fur-traders. The animal which is called the "true Indian dog" is nothing more or less than a tamed "cayote," or prairie-wolf (*Canis latrans*), a most appropriate name, by the way, for a noisier brute does not exist.

Space forbids me to say in this article anything more about the uses and habits of the Rocky Mountain Goat, but I am quite sure it must by and by prove a most valuable animal to acclimatize, and would be admirably fitted to live upon the higher peaks of the Scotch mountains, where the ptarmigan finds a suitable home. Its wool is even finer than that of the merino sheep; and if the mountain-goat was properly acclimatized, it would scarcely fail to prove a source of profit as a wool-bearing animal. Let us, then, hope the day is not so very remote, when we shall see this dweller in the Rocky Mountains, at present so little known and appreciated, roaming over the heather-clad hills of our own "tight little island."

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

CHAPTER I.

WOMAN IN GAUL AND BRITAIN UNDER THE CELT AND ROMAN.

I CONFESS to being one of those who feel a difficulty in believing that intellectual humanity is the mere spontaneous development of an original and primeval savage. Nor, although there be advocates for such a theory, can I believe that a savage woman, taking the word "savage" to mean man in a state, mental and bodily, which could only fit him to be the companion of animals, ever gave origin to the gentle and loving qualities, and to those winning graces, which render dear to us the female portion of the society among which we live—in other words, that there is any natural affinity whatever, derived from however remote a period, between Beauty and the Beast. I believe that the mankind among which we live has no inherent qualities in possession of which we were not at first created, and that the greater or less outward display of them, and the form in which they have, at different periods, shown themselves, depended

entirely upon the circumstances under which man lived. Setting aside the mere question of reproduction, man and woman were created, I believe, equal—one intended to be the affectionate and cheering companion to the other, with some peculiarities, physical rather than mental, which tended to make the one dependent upon and attached to the other. It is in this sense only that we have any right to call womankind the weaker sex.

But this is a question which I am not now called upon to discuss any farther. Our own modern society has grown out of a gradual amalgamation of different divisions and subdivisions of one great race of mankind, known under their different movements by a variety of names, but especially by those larger denominations of Celts, or of Romans, or of Teutons. My task is to trace, so far as I can, the position and the influence of womankind through some of these developments. Of course, as we go far back into time, our knowledge on this subject becomes very scant, through want of historical records. The Greeks and Romans, through whom all our knowledge is derived, only knew the different people whom we consider as our earlier forefathers, and whom they called barbarians, as people whom they sometimes met as enemies, and they had little opportunity indeed for studying their domestic life. The first chapter of a work like this, therefore, must necessarily be imperfect, and can hardly be considered as anything more than an introduction to the story itself.

So far as history throws any light upon the subject, Western, like Central Europe, appears to have been gradually occupied by successive waves of population, which all spread hitherward from the East. Of the first of these we know very little, and they are of no great importance to our subject. We are ignorant even of the extent to which they had originally occupied Western Europe; they appear never to have made any great name there, and they seem to have been driven onwards and crushed by the Celts. To the Romans, when they became acquainted with Gaul, the remnant of these peoples was known by the name of Aquitanians, and they are believed to be represented in our time by that very mysterious people, the Basques. Amédée Thierry's idea seems now to be generally adopted, that the Celtic race moved westward in two great successive emigrations. The first of these emigrations belongs to a remote period, of which we cannot fix the date, any more than we can of the second, except that we can be certain that it was at no great distance from what we call, in regard to Western Europe, the historic period. The new Celts drove their predecessors before

them still further westward, until they seem to have been represented only, when the Romans came here, by a portion of the inhabitants of the western coast of Gaul, and of a part of the British Islands. The subdivisions of the race are of little importance to the present subject. We will consider them all under the general name of Celts.

Under this name, or under that of Gauls (*Galli*), they were well known, in their earlier movements in Eastern and Central Europe, to the Greek and Roman historians. Among other great exploits, they invaded Greece, overran Macedonia and Thessaly, and plundered the Temple of Delphi. They entered Asia Minor, exacted tribute from most of the Asiatic states, and actually disposed of the throne of Bithynia, and placed upon it Nicomedes the First. They overran Italy, and burnt Rome. Yet all we know of the domestic condition and manners of this extraordinary people at this early period of their history, for we are going back to the beginning of the third century before Christ, is derived from two or three detached anecdotes, which have been preserved merely because they made a strong impression upon the imaginations of the Greeks and Romans. These will be better understood by one or two preliminary remarks of a general character.

Woman's position, in the earlier ages, was certainly not that given to her by nature, but one which arose out of the primitive forms of society. The earliest form of government was that called patriarchal. When the population was not large, and scattered over the earth, each head of a family was the ruler over all the other members of the same family; and as he himself acknowledged no superior authority, except in heaven, he possessed absolute power over them, extending to life and death, with the only exception, perhaps, of his wife, for her family had, in disposing of her, reserved a certain right of interference for her protection. Of the males, one only held a marked position as the next successor to the headship; the others were mere dependents upon the head, until, by some arrangement or other, they left the family to form each a family of his own. The females of the family, the daughters of the head, were, if anything, more dependent than the males, because they were looked upon as the weaker sex; they could not create independent families of their own; they were therefore employed in domestic labours, and in supplying the clothes and other necessaries of the whole family. The father sold his daughter in marriage into another family, and disposed of her entirely at his will. Alliances between families were formed, and family hostilities arose,

which led to war on a more or less extensive scale; and, to ensure the united action of many families in one cause, a chieftain was necessary, elected, of course, by the whole. This chieftain became a king, and through him kingly power was introduced, and gradually became a permanent institution. Kingly power, in its earlier period, meant war. This great revolution, for it was a great one, affected chiefly the mass, the families in confederation, if we may so express it, and not the members of each family, for the father still preserved the same authority over his sons, and especially over his daughters. Woman, however, did not universally submit to her position. Attempts to form matrimonial alliances according to her own inclinations were continually made, and often with success, and these sometimes led to violent feuds between families or tribes. Moreover, we find her, to judge by individual cases which are the only ones we see in history, constantly aspiring towards a superior position. But of this I have more to say in a subsequent chapter.

When, as the number of the population increased, the necessity of expansion compelled races to migrate in search of new homes, and when the migratory parties must of course act under kingly power or chieftainship, the patriarchal authority became, probably, more and more diminished. When we first obtain any knowledge of the different branches of the Gallic race, they had either passed through their great migrations, or were in the midst of them.

The natural effects of migration would be to modify, in some degree, the character of the Celtic women, as they must have had to pass through continual hardships and dangers, which would impress upon them the more masculine characteristics of endurance and courage. According to Strabo (lib. iii. c. 4), the Celtic women, in common with the Scythians and Thracians, were remarkable for their courage. In the Cimbric wars of Marius, about a century before Christ, we find both Teutons and Gauls accompanied to battle by their wives and families. In the great defeat of the Cimbri and Ambrones by that general in the neighbourhood of Aquæ Sextiæ (Aix in Provence), their women, who had been left with the chariots, threw themselves among the fugitives, and, reproaching their husbands with their cowardice, attacked the victors and saved the confederate Gauls and Teutons from destruction by their valour; and in the second great victory of that war, gained, in the year following, over the Gallic invaders of Italy in the Raudian plain, near Vercelli in Piedmont, the women of the vanquished stoutly defended their chariots long after the flight of their husbands, and, when they saw that further

resistance would be in vain, and Marius had refused their petition to be allotted as slaves to the priestesses of the Italian temples, which would have saved their chastity from the outrages of the Roman soldiers, they put their children to death and then slew themselves. At a later period, during the wars of Cæsar in Gaul, at the siege of Avaricum, the Gaulish women prevented their husbands from abandoning the defence of the town, and the assistance and encouragement they gave to them contributed greatly to the defeat of the Romans. Down to the latest period of Gaulish independence, it was the custom of the women to accompany the men in their warlike expeditions.* In the insurrection of Civilis and the momentary empire of the Gauls in the latter half of the first century of the Christian era, we are told by Tacitus that that chieftain, when he marched at the head of his Gauls against the Roman legions, placed in position behind his line of battle his mother and his sisters, and the wives and children of all his soldiers, that they might be an incitement to victory and a shame to those who gave way.†

These characteristics of courage and ferocity could only belong to women who were living in the midst of war and strife; the women, in fact, of tribes in a state of migration, though perhaps we might, from a comparison of other facts, think that they were characteristic of the Gallic race more than of any other. They were those traits of character which first struck the minds of the people of a higher degree of civilization with whom they came in temporary contact in their movements, and whose writers have chronicled them rather than their domestic virtues, of which therefore we know little. Yet, if they held such a position in presence of the other sex in the battle-field, they can hardly have been the slaves of their husbands at home. The two sexes must have marched in their migrations and in their wars almost, if not quite, on a footing of equality. We learn from the Greek writer Athenæus, that the Celtic women were celebrated for their personal beauty. They had no less a reputation for their chastity; and the philosophic Plutarch, who has left us a treatise in Greek, "On the Virtues of Women," has recorded more than one touching anecdote on this subject. One of these belongs

* It is curious that during the Middle Ages the Welsh, in their hostile excursions upon the English border, appear to have been usually accompanied by their women, who, however, were less distinguished on these occasions by their courage than by their erocity towards the wounded enemies, and by their aptitude at plunder. They were qualities derived perhaps from their Gaulish ancestors.

† Matrem suam sororesque simul omnium conjuges parvosque liberos consistere a tergo jubet, hortamenta victoriæ vel pulsis puborem.—Tacitus, "Hist." lib. iv. c. 18.

to the beginning of the second century before Christ. When the Gauls moved upon Greece and into Asia Minor at this early period, they as usual carried with them their women, and a great multitude of these remained the captives of the Romans in the great victory gained over the Tectosagi and their confederates, at Mount Olympus, by the Consul Cneius Manlius, B.C. 189. The guard of these captives was entrusted by the consul to a centurion, who possessed, in a more than ordinary degree, the vice of debauchery as well as covetousness, which then entered into the character of the soldier. Among the captives was the beautiful Chiamara, the wife of the chief of the Tectosages, who appears to have exercised the supreme command over the Gauls in this expedition. With this lady the Roman centurion became enamoured, and, after in vain attempting to prevail over her virtue by persuasions, he had recourse to violence. The centurion had acted contrary to his duty, and would have incurred punishment at the command of his own general; and, to calm the indignation of his victim, he promised to give her her liberty, but required a sum of gold amounting to the value of a talent by way of ransom. A place was appointed to which the money was to be brought, and Chiamara was allowed to choose one from the other captives to be sent to acquaint her relatives with the terms on which she was to be liberated. She chose an old slave of her husband's who chanced to be there, and the night following she was secretly conducted to the appointed place, where the money was brought in ingots of gold by two Gauls. The centurion began eagerly to weigh it, in order to assure himself that it was the full sum. While he was thus employed, Chiamara, in her own tongue, which was unknown to the centurion, ordered the two Gauls to draw their swords and slay him. She then took his head, wrapped it up in the skirt of her robe, and proceeded to join her husband; but when he approached to embrace her, Chiamara stopped, and threw down the head of the Roman before him, and then informed him what had happened. "Oh, wife," he said, in his exultation, "what a beautiful thing is fidelity!" His wife replied, "It is a still more beautiful thing to be able to say, 'No two men living will boast of having possessed me.'" This story is related by several of the Roman historians; Polybius, according to Plutarch, related, in a part of his history now lost, that he himself had an interview with this Gaulish lady at Sardis, and that he was astonished with her elevation of mind and understanding.

These examples, and many others we might quote, seem to show that chastity was one of the earliest virtues of womankind, and that,

even in the primitive ages, it was prized and insisted upon by the other sex. Some of the old writers, it is true, speak of tribes in a very low state of barbarism who lived in the utmost licence; but the old writers of this class were always on the look out for the marvellous, and those they speak of as living in this condition were people in remote parts who were only known to them by vague report. The advocates of the theory of the "savage" origin of mankind represent that, among many of the lower tribes of savages, female virtue is looked upon with a very indifferent eye, and seem to consider it as one of the developments of the human race, so that it is satisfactory to find from history that the contrary feeling becomes stronger, instead of weaker, in proportion as we go back. In fact, licence in this respect seems to have been hitherto one of the developments which accompany civilization, rather than one of the vices which it extinguishes.

When the Gauls, three centuries before the birth of Christ, marched into Italy and burnt Rome, they found there a people not far superior to themselves in civilization, and boasting of the same class of heroic virtues, modified only by the circumstance that they were a people stationary in their own country, making wars to extend their power, and not a people wandering over the earth in search of war and consequent plunder. The Roman women of the earlier period possessed most of the nobler qualities of their sex in a very high degree. They were not accustomed to follow their husbands and fathers to battle, and therefore they possessed none of that fierce courage displayed by the Gauls of their sex; but they often showed, under sudden misfortune, a constancy of mind which was truly noble. We need only appeal to such examples as that of Lucretia as evidence of the purity of their minds. They were educated with care, for we know that the beautiful Virginia, the heroine of one of the most touching stories of Roman history, went to school. The Roman women of the times of the kings and of the republic appear to have possessed in a special degree the good qualities which render domestic life happy; they are represented as faithful wives and excellent mothers, gentle, modest, and sober. They were forbidden by law to drink wine. Athenæus, in speaking of this fact, with the very ungallant reflection that "it is a well-known fact that all the race of women is fond of drinking," adds a piece of information which further illustrates some traits in the domestic life of the early Roman ladies—"It is impossible," he says, "for a woman to drink wine without being detected: for, first of all, she has not the key of the cellar; and, in the next place, she is

bound to kiss her relations, and those of her husband, down to cousins, and to do this every day when she first sees them; and besides this she is forced to be on her best behaviour, as it is quite uncertain whom she may chance to meet; for if she has merely tasted wine it needs no informer, but is sure to betray itself."* In proof of the excellent domestic character of the Roman women it is only necessary to state that, although the Roman husbands had almost unlimited power of divorce, the first occasion on which it was exercised is said to have occurred no less than five hundred and twenty years after the foundation of Rome.

In course of time, the character of the Roman women became depraved, and the change, when it began, was rapid and fearful. While, on one hand, they became proud and haughty, vain and cruel, on the other they lost all their old respect for chastity and sobriety, and became remarkable chiefly for their excess of licentiousness and debauchery. This is the character which they bore when their example began to exercise an influence over the inhabitants of Western Europe, the people of Gaul and Britain. But it will be sufficient here to state this circumstance; it is not necessary to enter into particulars. That which more especially interests us is their dress, because it no doubt influenced the costumes of the conquered races and that of the middle ages.

The ever-varying change in the forms and character of female dress which constitutes the fashion in modern times, was unknown to the ancients. The different articles which composed the female costume in ancient Rome, hardly varied from the earliest period of its history till it became mediæval. It consisted generally of three garments, very simple in form. The first was the tunic (*tunica*), which was simply what we call in modern times a shift, which was made of thin (sometimes almost transparent) material, fitted rather closely to the body, and had no sleeves. Over this was drawn another garment called the *stola,* differing only in shape from the *tunica,* in having short sleeves, covering only the upper part of the arm. This was usually fastened in front by means of fibulæ and brooches, the number and richness of which were regulated by the wealth of the individual. The tunic reached a little below the knees; the *stola,* on the contrary, was very long, while it was girded so as to make a quantity of broad folds under the breast, still, however, reaching so low that it half covered the feet. It was the characteristic dress of the Roman matrons, and was forbidden by

* Athenæus, "Deipnosophistæ," lib. x. c. 58.

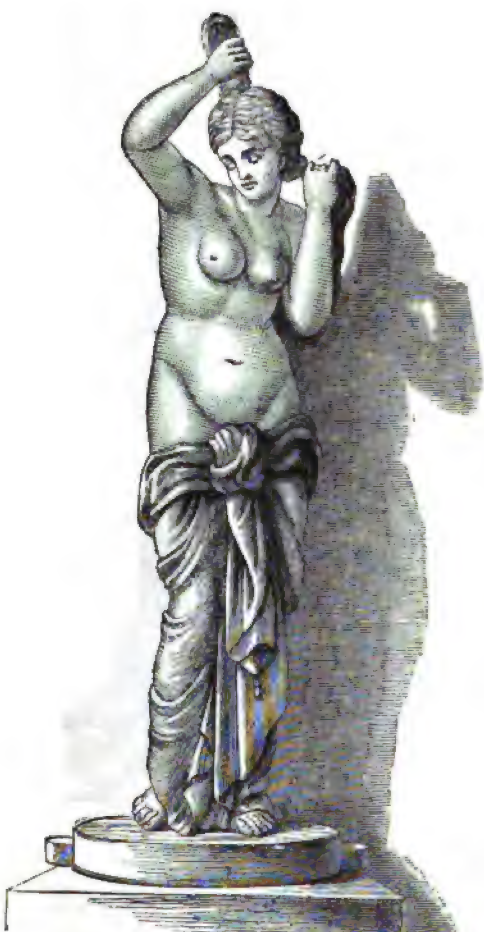
law to all who were not free women and of pure life. The tunica and stola constituted the ordinary dress of the Roman lady indoors;* when she went out she wore over the stola the third article of dress, the *palla*, or mantle. The palla resembled the toga of the male attire, and was put on in the same manner. It consisted of a rather long piece of cloth cut somewhat in the form of a half circle, though the curve was not exactly the segment of a circle. The wearer, in dressing with it, began by placing one end on her breast; it was then drawn over her left shoulder, round her back, under her right arm, across her breast, over her left shoulder and arm again, and the end was fastened behind. The left arm and shoulder were thus doubly covered, while the right arm was left bare. The accompanying cut, taken from one of the wall-paintings in Pompeii, represents a lady dressing herself with the palla, and will sufficiently explain itself. When on the body, it sometimes reached to the feet, but more frequently it reached a little below the middle or to the knees. This, however, was regulated entirely by the taste of the wearer, who was extremely particular in the manner in which it was adjusted, and bestowed more care and ornament upon it than upon any other article of her dress, except, perhaps, upon her *coiffure*.

PUTTING ON THE PALLA.

The Roman lady, no doubt, paid great attention to the latter. There is a beautiful picture among the wall-paintings found in Pompeii, representing ladies at their toilette, attended by servants, or slaves. At the time of which we are speaking, that when Roman manners were beginning to influence the people of Gaul and Britain, the slaves of both sexes in a Roman family of any respectability in life were very numerous; and, as in India at the present day, each was considered to have only one class of work to

* It would appear, from paintings found at Pompeii and elsewhere, that, in the privacy of home, the Roman ladies frequently retained the tunic as their only garment, and sometimes appear in a very extreme state of *négligé*.

attend to. In the Pompeian picture alluded to, one of the ladies is under the hands of the hair-dresser, who proceeds just in the same manner as the female arranges her own hair in the cut we give next. It is, no doubt, their especial province, and both she and her companion, who is adorning the lady's arm, seem to be attending to their duty with zeal. The form of *coiffure* most prevalent among the Roman ladies seems to have been the separation of the hair on each side from the top of the forehead; it was combed out, and formed into a large knot behind, which was held together by a hair-pin, on which latter was often bestowed very considerable ornamentation. A portion of the hair appears in many cases to be twisted, and carried over the top of the head; or this was sometimes replaced by an ornamental band of other material. The lady in the scene just described is seated in her simplest dress, the tunica alone, which is thrown down so as to leave the greater part of her body bare. The female represented in our second cut is in much the same costume, but she is dressing her hair with her own hands. The subject is also taken from a painting in Pompeii, as well as the cut which follows. As far as we can judge from the monuments which remain, the Roman women went commonly abroad without any covering on their heads; for, to say the least, anything like a hat or bonnet is rarely met with. There are, however, several figures among the paintings found in Pompeii in which the palla seems to be thrown over the head so as to form a cover for it, or some separate cloth



A ROMAN LADY AT HER TOILETTE.

is used for that purpose. An example of this is given in our third cut. It is interesting as being a part of the Roman costume

A ROMAN LADY'S HEAD-COVERING.

which seems to have been adopted by the people of Gaul and Britain, and was continued into the middle ages, forming, in fact, the model of the mediæval *couvrechef*.

(*To be continued.*)

THE HISTORY OF OZONE.

BY C. W. HEATON,

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There is good ground for believing that the true nature of the curious gas which, under the name of ozone, has excited the interest and attracted the researches of chemists for more than a quarter of a century, has at last been ascertained; for not only have we a theory which accounts satisfactorily for its formation and properties, and which is in perfect accordance with all known facts, but this theory has lately gained distinct confirmation from a direct crucial test. In many respects the history is a remarkable one, and it illustrates very strikingly the advantages and defects of the logical method by which scientific investigation is conducted. At every stage of the discovery new hypotheses have been framed, many of them on utterly insufficient data, and ever and anon the advancing tide of fact has swept them away one by one, until, at length, one has arisen which, having struck into more coherent soil—to carry out the simile—has only been cemented into greater solidity by the action of the waves. It is almost painful, in reading a chapter of scientific history like this, to note the mass of careful reasoning apparently wasted; the succession of brilliant ideas, each one set forth by its originator in full belief of its truth, but which has been superseded almost before it was known. Science marches on over fallen hypotheses, just as soldiers mount a breach on the dead bodies of their comrades.

In 1774, Priestly discovered oxygen, and the wonders of the new-found element soon attracted the study of all the chemists of Europe. Besides the systematic researches thus called forth, and which were destined to bear such noble fruit, a host of detached experiments were made, and one of these, seen by the light of subsequent knowledge, was of the highest importance. In 1785, the electrician, Van Marum, took it into his head to pass electric sparks through oxygen, probably as a mere tentative experiment to see what would happen. He found that the oxygen acquired a peculiar smell, and with it the power of acting directly on mercury. In fact, he obtained ozone; but chemical method being still young, and Van Marum, probably, no heaven-born genius, but little real knowledge was gained by the experiment. The smell was the same as was observed in the air in the neighbourhood of an electrical machine in

action, and Van Marum, therefore, contented himself with assuming that it was the natural smell of the "electrical matter." In this state the subject remained until 1840, when Professor Schönbein, of Basle, took it in hand, and soon brought to light a number of curious facts. He found that the substance could be formed by several distinct processes; that it was present in the oxygen obtained by the voltaic decomposition of water, and that it might even be produced without the agency of electricity, by the slow oxidation of phosphorus, or, in other words, than when one portion of oxygen was absorbed by phosphorus, another portion was always converted into ozone. The properties of ozone, or, more properly, of ozonized oxygen, were likewise studied by Schönbein with great care and ingenuity. By far the most remarkable of these was found to be its extraordinary oxidizing power. A great many substances which are incapable of uniting directly with oxygen, even at a high temperature, are instantly oxidized by ozone; and are not only oxidized, but are raised at once to their highest known state of oxidation. Of this phenomenon silver affords a good illustration. For the same reason ozone is a powerful bleaching and disinfecting agent, bearing, in these respects, so close a resemblance to chlorine that Schönbein at first imagined that it was a new analogue of that element. But this was disproved by the fact that the compounds obtained by the combination of ozone with other bodies were oxides, differing in no respects from the oxides obtained by ordinary means. Upon its active oxidizing power, Schönbein founded a most delicate test for ozone. It is well known that iodine forms a blue colour with starch, but that this reaction can only be obtained with *free* or uncombined iodine. Iodide of potassium may be mixed with starch without the production of any colour, and the oxygen of the air is quite powerless to decompose the iodide, but the smallest trace of ozone effects the decomposition immediately; caustic potash is formed, and the mixture becomes blue from the formation of the so-called iodide of starch. This mixture, spread on slips of paper, constitutes the "ozone test-paper" now so largely employed, and "ozonometers" are merely instruments for registering the depth of coloration produced by the exposure of one of the papers for a certain time to a certain quantity of air. The indications of the ozonometer are merely comparative, being expressed on an arbitrary scale ranging from 1 to 10. The remaining properties of ozone may be dismissed for the present in few words. It is insoluble in, and without action on, water. It is destroyed by heat—a temperature about equal to that of melting tin being sufficient to convert it

entirely into common oxygen; and finally, it is destroyed by black oxide of manganese and some other substances, which are not themselves oxidized by it.

All these, and a great number of similar facts, we owe to Schönbein, who has pursued his discovery with a perseverance and zeal which cannot be overrated. It is true that his researches have been almost entirely qualitative in their character, and that he has therefore arrived at erroneous conclusions as to the causes of the phenomena which he has studied; but this circumstance must not induce us to forget the gratitude we owe him for his very good and useful work. He stands to ozone something in the relation that Priestly stood in to oxygen, while the exact labours of Lavoisier have their parallel in those of Fremy and Becquerel, Andrews and Tait, Soret, and several other investigators.

Passing by the crude theories of the earlier workers on ozone, we find that the first step towards the true theory was made by Marignac and De la Rive, who proved that ozone contained no other element than oxygen, and consequently that it could only be some altered, or "allotropic" form of that element. In 1852 another important stage in the progress was reached by Becquerel and Fremy, who not only confirmed the conclusions of Marignac and De la Rive, but demonstrated that pure oxygen might, by the prolonged action of electricity, be converted entirely into ozone. It is true that this can only be effected when the ozone is absorbed as fast as it is produced—when, for instance, the electric sparks are passed through a tube of oxygen inverted over mercury or iodide of potassium—and that it has hitherto been found impossible to prepare ozone free from common oxygen, but the total conversion is none the less significant of the true nature of the substance. In 1856 Dr. Andrews showed conclusively that ozone was the same by whatever process it was prepared, and finally demolished the arguments by which Williamson and Baumert had sought to prove that it was a teroxide of hydrogen.

So far the investigation of ozone had been of a satisfactory character. Erroneous experiments had indeed been made, and incorrect theories had, as a matter of course, been founded upon them. But still the theories followed logically from the supposed facts, and the experiments themselves were conducted with care and honesty. But Schöbein, although he scarcely touched the quantitative methods, on which alone a theory can be safely based, ventured, in a letter to Faraday, dated June 25, 1858, to propound a new hypothesis to which he has ever since adhered, and which has never

wanted advocates, although it has been distinctly and formally disproved. He assumed the existence of two different and opposite kinds of oxygen, a negative and a positive kind. The former—the variety obtained by electricity, the oxidation of phosphorus, etc.—he continued to call ozone, the latter he distinguished as *antozone*, and he asserted that common, or neutral oxygen was formed by the union of both kinds. These hypothetical constituents of oxygen were furthermore assumed to exist in a great variety of oxides. Those which contained ozone were called *ozonides*, and among them were numbered the higher oxides of manganese, chromium, and iron, and the oxides of the noble metals. The opposite class of oxides, the *antozonides*, comprised the peroxide of the metals of the alkalies and alkaline earths, the peroxide of hydrogen, and a few other substances. This elaborate hypothesis was based almost entirely upon the circumstance that when one of the so-called ozonides was mixed, under suitable conditions, with an antozonide, common oxygen was evolved, the ozone of one, according to Schönbein, combining with the antozone of the other. But without denying that Schönbein's hypothesis is capable of accounting for facts like these, we are compelled by the researches of Sir B. C. Brodie to believe that they can be explained as satisfactorily and more simply by a reference to the ordinary laws of chemical change. The recently ascertained density of ozone is, moreover, quite inconsistent with the truth of Schönbein's hypothesis, which, indeed, I should not have referred to here, but that it is still accepted by a considerable section of scientific men.

We come now to a much more important and genuine set of discoveries. In 1860, Andrews and Tait published in the "Philosophical Transactions" a paper "On the Volumetric Relations of Ozone," which must be regarded as the most important memoir upon the subject which has been produced since the original discovery by Schönbein. The authors found that, during the formation of ozone by the passage of the electric discharge through oxygen, a contraction of volume took place, and, consequently, that ozone must be heavier than oxygen. The amount of contraction was in direct proportion to the amount of ozone formed. It was greatest when the silent electrical discharge was employed, which likewise developed the greatest quantity of ozone; but in no case did it exceed one-twelfth of the original volume of the oxygen. On heating the gas, so as to destroy the ozone, the original volume was exactly restored. They then set to work to determine what further contraction of volume could be produced by the removal by mercury, or some

ether absorbent, of the ozone which had previously been produced. This second contraction, they anticipated, would give the volume of the ozone which had been absorbed by the mercury; and as its weight could be easily ascertained by finding the amount that the mercury had gained, it would be easy to find the actual density of ozone. The result is a powerful example of the way in which experiment often contradicts hypothesis. *The removal of the ozone did not alter in the slightest degree the volume of the gas.* An imaginary example will make this more evident. We take:—

100 cubic inches of oxygen.

By the action of the electric discharge this is reduced to

92 cubic inches of ozonized oxygen,

which is really a mixture of ozone and oxygen. After the absorption of the ozone by mercury there remains—

92 cubic inches of oxygen.

So that the ozone appears to occupy no volume at all, and its density to be absolutely infinite. This curious experiment was repeated by the authors in several forms, but the result was always the same. They honestly expressed themselves surprised and puzzled at the phenomenon, and were very guarded in their attempts to account for it. New light, however, soon poured in. The experiments were too striking and too carefully performed to remain long unfruitful; and the very absurdity which they seemed to involve suggested to the acute mind of Dr. Odling a simple solution of the problem. To appreciate the force of this solution, it is necessary to bear in mind the theoretical conception of the nature of gases which modern investigation has enabled chemists to frame. To prevent unnecessary digression, I will state it dogmatically, giving none of the reasons which have led to its adoption, and omitting the real or apparent exceptions, which are, indeed, very few in number.

Every gas, whether elementary or compound, consists of minute particles called *molecules*. The molecules of all gases, whether elementary or compound, have an equal size, and, at the same temperature and pressure, a given volume contains always the same number of them. Hence all gases are equally affected by purely physical operations, such as increase or diminution of temperature or pressure. The differences between gases depends entirely upon the nature, or, so to speak, upon the *structure* of the molecules. The molecules are in reality aggregations or clusters of ultimate indivisible *atoms*. The nature, the number, and the arrangement of the atoms in each molecule determines its weight and its properties.

Elementary molecules contain atoms of only one kind, the number differing in different elements. Thus the molecules of mercury and some other elements contain but one atom; the molecules of hydrogen, oxygen, potassium, etc., two atoms; and the molecules of phosphorus and arsenic four atoms. The molecules of compound gases contain two or more different kinds of atoms, the total number of which may be only two, but may amount to sixty or eighty, or even more. The formulæ used by chemists are now invariably constructed so as to denote one molecule of each element or compound, each symbol denoting one atom. Thus, $Hg . H^2 . O^2 . P^4$., represent single molecules of mercury vapour, hydrogen, oxygen, and phophorus vapour; and $HCl . H^2O . H^3N$., single molecules of hydrochloric acid, steam, and ammonia. The hypothesis is, of course, only a convenient explanation of well-known and certain facts; but even if the atomic theory were abandoned, the formulæ might still be used to express the facts.

Dr. Odling's theory of ozone may now be given in very few words. The molecule of oxygen contains two atoms, the molecule of ozone contains three; so that the formation of the latter body simply means the condensation of oxygen into two-thirds of its former volume. As the formula for oxygen is O^2, so that of ozone is O^3, and its oxidizing power is due to the ease with which each molecule loses its third atom of oxygen. On this view Andrews' and Tait's results become mere matters of course, as may easily be seen by returning to our former example.

100 cubic inches of oxygen yield 92 cubic inches of ozonized oxygen, because 8 cubic inches coalesce with 16 to form 16 cubic inches of ozone.

If the gas is heated, the original volume is restored, because the 16 cubic inches of ozone, O^3, yield 24 cubic inches of oxygen, O^2.

When the ozone is absorbed by mercury, it is really only the third atom which combines with the mercury, the 16 cubic inches of ozone therefore become 16 cubic inches of oxygen, and the volume remains unaltered

This beautiful hypothesis, although accounting perfectly for all known facts, was yet, nevertheless, but a probability. One link was lacking in the chain of evidence, and it is just that link which M. Soret has supplied by a happily-devised experiment. He has discovered that whereas most substances only remove the third atom of oxygen from ozone, oil of turpentine is capable of absorbing *the whole molecule*. If the 92 cubic inches of ozonized oxygen in our imaginary experiment were treated with oil of turpentine in-

stead of mercury, a white cloud would be produced, and the residual oxygen would be found to occupy a volume of only 76 cubic inches. The only possible explanation here is that the 92 cubic inches consisted of 16 of ozone, O^3, and 76 of unaltered oxygen, O^2, and that the former was seized upon entire and removed in the solid form by the oil of turpentine. There can hardly be a doubt that this confirmatory experiment will settle the question, and that the nature of ozone, and the cause of its peculiar powers, will henceforth be regarded as established.

With this knowledge in their possession, and a very considerable mass of valuable information about the properties of the gas, chemists can now approach with some confidence the very difficult question of the presence and functions of ozone in the atmosphere. It will hardly be believed by some, but it is nevertheless true, that it is only within the last few months that ozone has been distinctly proved to exist in the air at all. Schönbein, in 1840, found that his test-paper became blue when exposed to the air, and hence concluded that ozone was present in it. Here was a new and easy field for scientific discovery! Test-papers were exposed in all directions, and countless observations on the amount of ozone in the air were recorded. But unfortunately a few radical errors and doubts have enshrouded these well-meant efforts, and the greater part of them are therefore worthless. Ozone is not by any means the only gas which affects the papers. Nitrous and nitric acid and chlorine, the two former of which, at any rate, are known to exist in the atmosphere, have an equal effect upon them, and sunlight alone is capable of effecting the decomposition, even when the paper is enclosed in a sealed tube. Hence, in the great majority of researches, it was quite impossible to say whether any—and, if any, how much—of the coloration was really due to ozone. Even in those experiments where most pains were taken to avoid doubt, as in the recent researches of Dr. Daubeny, some ambiguity still remained, so that the more cautious chemists hesitated to pronounce absolutely that ozone was a constituent of the atmosphere. Within the last few months, however, Dr. Andrews, to whom we were already so largely indebted, has communicated to the Royal Society some careful experiments, which seem to prove that the observed effects can only be due to ozone. The most decisive proof consists in passing the air through a moderately-heated tube, which is found to destroy all traces of its power on the test-paper.

This point also, then, seems to be settled, and it only remains to ascertain with equal exactness how the ozone is formed the

variations in quantity to which it is subject, and its probable functions in nature. And here, unfortunately, we enter upon a region of doubt and contradiction. No absolute quantitative method has, as far as I am aware, hitherto been tried for the determination of ozone in the air, and the comparative observations which have been collected in such abundance are, as we have seen, for the most part of more than doubtful accuracy. Even the most reliable of them only establish a few facts, and are barely sufficient to warrant us in guessing at their probable cause. As to the distribution of ozone, it is certain that, as a general rule, country air contains more than town; and air which has come direct from the sea, more than that which has swept over a large tract of land. Dr. Daubeny found that at Torquay, in the winter months, ozone was present in the greatest quantity in the south-west, west, and south winds, and in the smallest in the north winds; whereas at Oxford, east wind brought most and the north-west least ozone. The experiments were, however, somewhat vitiated by the fact that the latter series was made in the summer months. Ozone is always absent from the air of an inhabited room, even when present in the surrounding atmosphere.

As to the mode in which ozone is generated in the air, we have only probabilities to guide us. There can hardly be a doubt that it is formed to some extent by the agency of lightning, and it is possible that this is the sole mode of its production. Some writers assert and some deny that it is present in the oxygen evolved by plants under the influence of light; but though such a formation is probable enough, the evidence, both for and against it, is at present inconclusive. And lastly, it is possible, though still unproved, that it may be formed during some of the processes of slow oxidation which are so common on our globe.

However it is formed, it is at least certain that ozone exists in the air, and that, though small in quantity, it must, from its extraordinary activity, have important functions to fulfil in nature. But this very certainty has, unfortunately, been a fruitful source of wild assumptions and mere speculative guesses, doing infinite harm to the progress of true knowledge. Some have asserted, and have attempted to prove by perfectly inconclusive reasoning, that ozone arrests infection, and destroys the germs of epidemic disease. It is highly probable that such is the case, and it is certain that its presence is incompatible with that of many noxious gases. But then it is *not* certain that epidemics are due to noxious gases, and if, as is more likely, they are propagated by spores, we have yet to

prove that the minute trace of ozone in the air is capable of destroying those spores. We can no more assume it than we could assume that it killed birds. Even more vague, and much more improbable, is the floating notion that an excess of ozone in the air "does us good." Men talk of running down to the seaside "to get a little more ozone," just as if it were not possible that the little more ozone might do them harm instead of good when they got it. In large quantity it is certainly an intensely powerful irritant poison, and that it is useful in small quantities is the merest assumption. As to the notion of its assisting the process of blood-oxidation, the probability is all the other way, for its energy would be much more likely to cause it to oxidize, and destroy the lung itself than to permit it to pass quietly into the blood, and effect the work performed by the more gentle oxygen. The simple fact is, that we know next to nothing about this branch of the subject; and if, instead of guessing at random, we were to set to work to try to elucidate some of the obscurities by which it is surrounded, or, at any rate, were to wait until others had done it for us, we should act a much more sensible and modest part.

For the future, there is every hope. The main elements of the inquiry have already been acquired, and a strong body of experimenters are at work upon it. The British Association has appointed a committee to investigate some of the moot points, and from the high eminence of every member of it, we may justly anticipate some important contributions to our knowledge.

THE MICROSCOPE IN EDUCATION.

On all hands the active members of society by whose agency its course is determined in this country, are busied with the great question of national education. Difficulties that a few years ago were practically insurmountable are rapidly giving way under combined attack; parties who were hostile have agreed to coalesce, theological antagonisms are remitted to more appropriate questions, and the field for successful exertion, if not actually clear, is becoming so with a rapidity that is characteristic of the age of railways, telegraphs, and a free press. The highest class of thinkers demand education that it may fulfil its noblest purpose of developing men and women into the highest types of which their nature, under existing conditions, is capable; while more materialistic, and less philosophical minds wish for its prompt diffusion, chiefly that we may more effectually compete with foreign manufacturers in the career of skilled production and in the race for wealth—a thing good and necessary in its way. Others again, with an eye to political interests and the bearings of democratic change, consider that national safety depends on national instruction, and they believe that as the number of those who contribute to make that irresistible force called "public opinion," is rapidly increasing by the admission of actors in the process of large classes formerly excluded, it is absolutely essential that the new comers should be qualified for the functions they have to perform.

The education of the working classes specially occupies the minds of many social reformers, and others devote themselves more particularly to improve middle-class schools, colleges, and universities and thus throughout society there is an educational ferment working with a vigour and at a pace entirely unprecedented in this country.

If we look to the character of the education demanded, we cannot but notice an increasing preference for a knowledge of things, or of facts, and especially of such as belong to the domain of physical and natural science, and which, therefore, come into incessant contact with the duties, the requirements, and the convenience of daily life. A strong reaction is taking place against the purely literary training which has hitherto been held sufficient in many of our chief schools; modern languages are pitted against ancient tongues, physics are thrown at nonsense verses, and chemistry voted of more consequence than formal logic or metaphysical

disquisition. The tendencies of society, whether of action or reaction, are seldom entirely wise; but the most judicious course is to accept, and be thankful for, such a grand motive power as outbursts of national aspiration furnish, and to utilize it to the largest possible extent. Just now, the claims of science are becoming paramount, but there need be no fear of overcultivating the scientific faculties, as there is no ground for supposing that other portions of human nature are going to be buried under piles of fact. The more advanced sciences cannot be efficiently taught, except in such a way as to make them instruments of mental discipline. A manufacturer may wish his boy to learn chemistry, simply with a view to his dyeing cotton or silk, but if it is attempted to teach him the science only in its applied form, the fallacy and absurdity of the process will soon appear. Sciences must be taught for their own sake, and the truth that is in them duly brought out, or it will be found that the teaching will fail, when tested economically, quite as much as it obviously must fail when tried by the higher standard of its capacity to promote mental growth.

We have in this country no well educated *classes*, though in various classes we are fortunate enough to possess many well educated individuals who would be immensely more useful if those about them were in a better condition to receive the impulse they are competent to give towards a more reasonable, and consequently a more happy method of life than usually prevails.

Assuming that scientific instruction is to form an essential portion of the education of the future, the possession of at least a moderate quantity of philosophical apparatus will be regarded as necessary by all families raised sufficiently above want to afford its purchase, and the most popular and available instrument is assuredly a *microscope*, from the range of information it is able to impart, and from the continuous pleasure so easily procurable from its use.

In the selection of such an instrument regard of course must be had to the state of the intended purchaser's pocket; but it may save loss of money and vexation of spirit, if we caution those who are about to enter upon microscopic pursuits, not to imagine that the lowest priced instruments can possibly prove satisfactory. A microscope that will not show all ordinary objects *well*, bringing out their beauty as well as their structure, will soon be voted a tiresome and unsatisfactory machine. Only advanced students can make any good use of the refinements of the most costly instruments and of the most elaborate apparatus, but if only three or four pounds is given for a microscope with a couple of powers, a bull's-eye

condenser, and a few *et ceteras*, it will infallibly be found insufficient and inconvenient within six months of its acquisition, if it is kept in constant use. A mechanical stage is a luxury, not a necessity, and many pieces of apparatus may be dispensed with, if their purchase is inconvenient, without much harm; a multiplicity of powers, though handy, is not essential; but certain things should be considered prime requisites, and no instrument without them should be purchased, if the cost of a better can be afforded. As presents for schoolboys to practise upon, cheap and poor microscopes may do very well, but for any better purpose we should consider the following things necessary. First, the instrument must be steady, and whatever motions it may have must be reasonably smooth. The great makers bestow upon their first-class stands a quantity of skilled labour that of necessity makes a large addition to the price, but if the student desires a cheaper instrument he should look out for one in which the main movement of the coarse adjustment is fairly made, and upon a sound principle. Many cheap microscopes are so constructed that when the great screws are worked to bring the body up and down, they must *wabble* and jerk, defects which will get worse and worse the more the things are used. The fine adjustment should be tested in the same way. If it makes the object appear to move about on the stage, it will be a perpetual plague. In bad microscopes it is common to find the stage pierced with a little round hole the size of a shilling or a halfpenny, over which the object is placed. Such limited apertures are very inconvenient, as they interfere with the use of illuminating apparatus.

In the choice of an instrument, the inquiry should be made whether it will conveniently carry such apparatus as a spot lens, parabolic illuminator, achromatic condenser; and if not, it is better to reject it, provided the price of a superior stand can be afforded.

In the purchase of powers, a couple of good ones is better than half a dozen bad. Low powers, such as Ross's 4-inch, will give great pleasure and amusement. With only a small sum to spend, second-class low powers may be tolerated, but in the selection of ¼-inch power or upwards, the *best* should be obtained. A fine quarter by one of our great makers, with additional eye-pieces, is better and more useful than a set of high powers of an inferior kind.

Families should not too readily grudge the price of a good instrument, as it will last their lives; and it is not a little barbarous and absurd to find costly finery in a house destitute of appliances for the cultivation of the mind.

Let us suppose a microscope bought—what is to be done with

it? Here we fall back upon the tendency of the times towards scientific education. Every one ought, for example, to know some at least of the elementary truths of anatomy and physiology. Foolish people fancy that such matters are only fit for those who may be destined for medical pursuits; but every one is interested in the preservation of health, and it is absurd that society should bring up men and women entirely ignorant of the nature of the human frame. Even a baby may be regarded as a complicated piece of philosophical apparatus which it is folly to commit to the charge of a *curator* who has not the remotest idea of *how it goes*.

With the aid of a microscope, and a few well-selected preparations, sound elementary knowledge of the nature of bones, muscles, nerves, lungs, skin, etc., may be easily and very agreeably obtained, and the ideas thus communicated will not only enlarge the mind, but furnish useful hints for practical conduct all through life. It will be found that when objects of the kind referred to are seen, books relating to them will become interesting, although they might prove most wearisome to plod through without such aid.

When once the simpler elements of physiology have been mastered, a multiplicity of objects in the lower ranks of organic life become of great interest. Portions of insects, exemplifying the means by which they are enabled to do something like what man does with a different apparatus, in the way of locomotion, food catching, digestion, etc., rise in value as objects of study or amusement just in proportion to the range of physical or physiological knowledge previously acquired.

It will be conceded by all acquainted with the matter, that a course of microscopic instruction of the kind indicated should be regarded as an indispensable feature in every civilized educational scheme.

Passing from the animal to the vegetable kingdom, a great deal of important information furnishing food for reflection may be obtained, by directing the microscope to readily accessible plants. Those who do not intend to study botany as a science, ought yet to know the appearance and functions of the principal organs by which plant-life is carried on. Stamens, pistils, pollen, vessels of different descriptions, seeds, tissues, and cells of plants, ought to be familiar things to all who have any pretence to education, and though mere reading about may be perplexing and wearisome, seeing them properly exhibited under the microscope rarely fails to instruct and delight.

The vegetable world offers an endless succession of beautiful

microscopic objects, and their dissection involves no unpleasant processes or disagreeable tasks. To know plants only as they appear to the unassisted eye, is to have but a slight and feeble acquaintance with their larger varieties only, for multitudes of the most exquisite forms of vegetation can only be seen by the microscope's aid. In the green slime or scum upon stones or ponds, in moulds, mildews, etc., what elegant shapes and charming tints appear; and what astonishment seizes the mind when the eye first sees undoubted plants move about and change their shapes like the Euglenæ, as if stimulated by a purpose and impelled by a will.

If the microscope is used simply as a plaything, it soon meets with the fate of other playthings, in being thrown aside. More rationally employed, it provides a constant stimulus to inquiry. The observer finds his curiosity excited first in one direction and then in another. To explain one thing he wants to know a little chemistry, to understand another a little physiology, and so forth from day to day.

When the microscope is merely made to serve the purpose of an elegant amusement it is by no means to be despised, nor ought those who so employ it to be ridiculed for their taste. Looked at from a recreational point of view, microscopy is well worth taking up, though we certainly advise its employment in a more studious spirit and in a systematic way. Indeed, the more it has been used for study, the more it may be used for amusement, because the observer, who has acquired an extensive range of information, will be much better qualified to develope its recreational capacities than can possibly be effected by a comparatively uninstructed practitioner.

Fresh objects will, as a rule, be more interesting than slides, and living ones are preferable to dead: but there are many things, such as details of structure, that can only be seen in well-made preparations; and any one who buys a microscope should learn how to prepare all ordinary slides, for which abundant instructions are given in well-known works.

In families much interest is easily excited by illustrations of the structure of ordinary things in regular use, and but little skill is required to make thin slices, sections, and other preparations necessary for their display. A little practice will easily lead to the discovery of the powers and modes of illumination best employed. It is best to begin with the lower powers, and, though an object may be transparent enough for transmitted illumination, it is often worth trying it also by reflected light. Bodies, again, that are

opaque in a mass become translucent in their sections, and many which present no beauty with ordinary illumination become splendid with polarized light.

We shall, from time to time, furnish beginners with information which will assist them in microscopic pursuits; and when papers refer to subjects that may at first sight seem a little beyond their reach, they will frequently find that the difficulty may be made to vanish with much less trouble than they suppose.

Without any prejudice in favour of particular pursuits or peculiar methods of instruction, we feel bound to give a preference to plans which bring truths home to the eye, and with this view it is impossible not to regard the microscope as one of the foremost instruments for the communication of knowledge, equally adapted to class teaching and to private study. No better investment can be made than in a good microscope, a binocular one being preferable. A bad instrument or bungling manipulation will, no doubt, do damage to the sight; but a good one, properly arranged, will show small objects as plainly and as comfortably as larger ones can be seen with the unassisted eye.

As a general guide to purchasers, we may say that microscopes below £5 in price are not likely to satisfy any one who acquires moderate skill in the use of such an instrument. From £5 to £10 a much more generally useful instrument may be obtained. From £10 to £20 a good binocular stand, with a couple of powers and several pieces of apparatus, may be purchased. A considerable improvement in quality of the brass-work and movements, with more apparatus, will require an outlay from £20 to £30; while those who can afford it should have the very best, at from £50 to £100, which need not be spent all at once, unless the purchaser is quite sure what he will want.

METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

BY. G. M. WHIPPLE.

(*With a Plate.*)

OCTOBER, 1867.

INSTEAD of our usual tabulated observations, we shall henceforth give the observations in the form of curves of monthly atmospheric variations.

In the diagrams the upper figure represents the movement of the barometer from day to day, derived by connecting the points marking the mean daily pressure.

Below the barometer curve we have the curve of maximum daily temperature, next the mean temperature of the day, and then the minimum temperature of the same day.

The lowest curve is that of relative humidity. Here increasing ordinates, or a rising of the curve, denotes increasing dryness of the air, complete saturation being represented as 1·00.

The rainfall is shown by the vertical lines at the bottom of the diagram, which indicate, by their length, the depth of rain fallen in the twenty-four hours between 10 A.M. of the preceding day and 10 A.M. of the day on which it is marked.

ATMOSPHERIC PRESSURE.—The month commenced with a high barometer; on the 1st it stood at 30·421; it then fell gradually, with the exception of a slight rise on the 4th, till it reached 29·590. An upward movement followed to the 11th. A fall again took place on the 12th and 13th, and the barometer remained low until the 19th, when it read 29·691. The readings then increased up to 30·217 on the 22nd; after which a fall occurred to 29·875 on the 24th; it rose on the 25th to 30·160, afterwards falling rapidly; on the 27th it reached the lowest point in the month, 29·382; rising on the 28th, and a little on the 30th, read 29·937 on the 31st.

The times of greatest movement of the barometer were, a great fall from 1d. 5h. P.M. to 2d. 6h. P.M., and a rapid fall from 9d. 3h. P.M. to midnight, followed by a rise to midnight on the 10th; there was also a rapid fall from 26d. 10 A.M., to 27th, noon; then a sudden rise, followed by a more gradual rise through 28th; after that it gradually fell.

The mean barometric pressure for the month was 29·911 inches.

TEMPERATURE.—Similar to the barometer, the thermometer fell

at the commencement of the month, from 50·2° on the 1st, to 42·0° on the 4th. The mean temperature remained at nearly the same point till the 11th, when it began to increase, reaching 57·4° on the 15th; it fell the next few days, but rose again the 22nd, when the highest mean temperature of the month, 58·3°, was attained. The only noticeable change after this date was a low temperature of 43·9° on the 28th, followed by a rise to 55·2° on the 29th.

The highest maxima occurred on the 15th, 17th, and 22nd, the thermometer on those days recording 63·2°, 62·4°, and 64·6°; the lowest maxima were the 4th, 48·3°; 9th, 47·9°; and the 11th, 47·1°.

The lowest minima recorded were the 6th, 30·2°, and the 11th, 30·0°. The highest minima were those read on the 22nd, 52·7°; 23rd, 54·1°; and the 31st, 52·9°.

The days on which the greatest daily range of temperature occurred were the 14th, 23·4°; and the 6th and 21st, 23·0°.

The least ranges were, 23rd, 6·9°; 30th, 5·2°; and 31st, 4·8°.

The most noticeable features of the thermograph records for the month were a sudden fall of 5°, which happened at 8d., 2 P.M., and an almost instantaneous decrease of 10° recorded at 12.50 P.M. on the 27th, at the same time that the barometer reached its minimum, and suddenly rose.

Between 11th, 6 P.M., and 12th, 8 A.M., the thermometer did not vary 1°.

The mean monthly temperature was 50·0°.

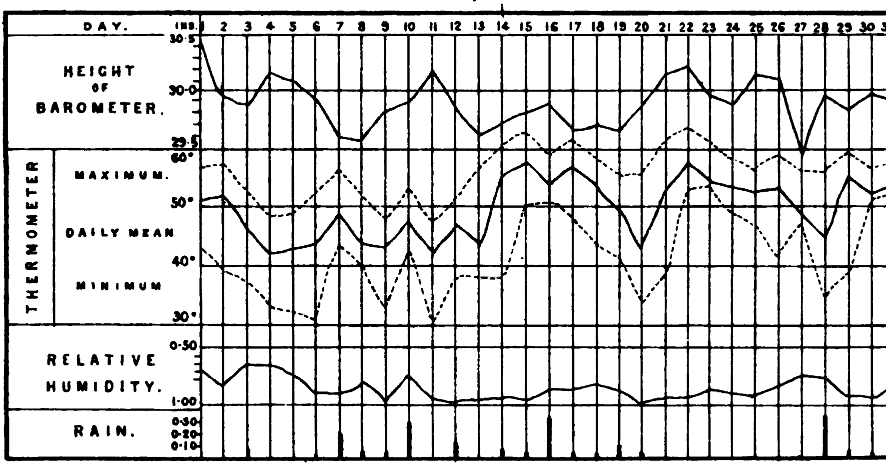
Relative Humidity.—The days on which the amount of aqueous vapour present in the air was least, were the 1st, 3rd, 4th, 5th, 27th, and 28th, when it was ·63, ·65, ·67, ·70, ·77, and ·74, respectively; complete saturation being 1·00. The days of greatest humidity were the 11th, ·96; 12th, ·97; 13th, ·96; and 20th, ·99.

Rainfall.—Rain was recorded as follows:—

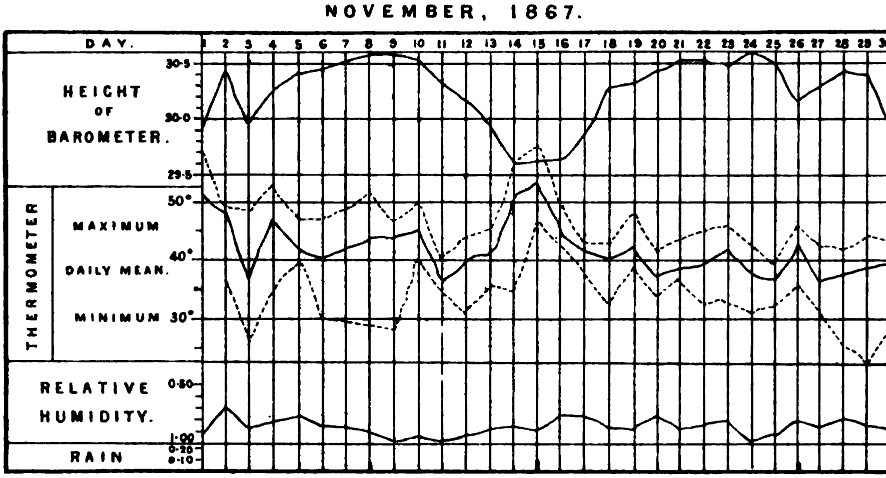
DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
3......	0·040 inch.	14......	0·030 inch.	20......	0·005 inch.
7......	·172 „	15......	·004 „	28......	·340 „
8......	·010 „	16......	·353 „	29......	·023 „
9......	·005 „	17......	·010 „	30......	·014 „
10......	·280 „	18......	·030 „	31......	·066 „
12......	·153 „	19......	·080 „		

DIAGRAMS, REPRESENTING THE METEROLOGICAL VARIATIONS AT THE KEW OBSERVATORY.

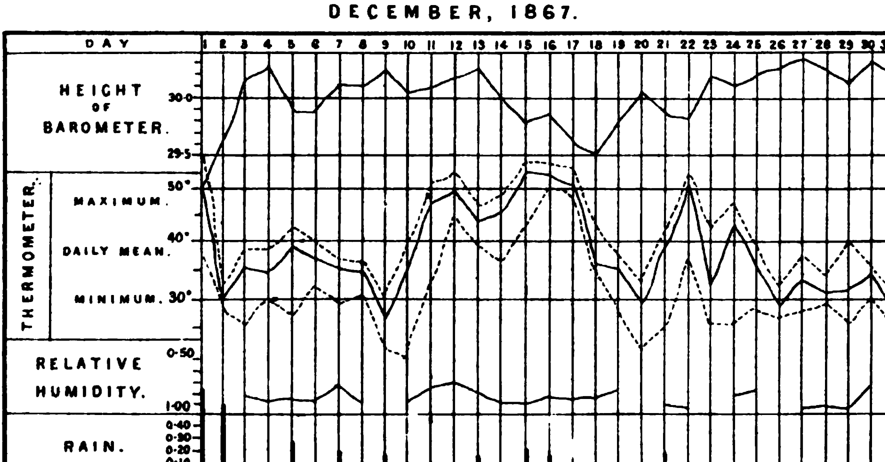
OCTOBER, 1867.



NOVEMBER, 1867.



DECEMBER, 1867.



The total amount of rain fallen in the month=1·615 inch.

The velocity of the wind was not recorded throughout October.

The principal direction of the wind was—

South-Westerly—2nd, 9th, 16th, 17th, 18th, 19th, 21st, 22nd, 26th, 29th, and 31st.

North-Westerly—3rd, 4th, 5th, 8th, and 28th.

Northerly—10th.

North-Easterly—25th.

South-Easterly—14th, 15th, 23rd, and 24th.

The wind being very light on the remaining days.

November, 1867.

Atmospheric Pressure.—The fluctuations in the height of the barometric column were not so numerous as in the previous month, but extended over a greater length of scale.

The mean height on the 1st was 29·937, differing but slightly from the last observation of the preceding month. About 2 p.m. it commenced to rise, and continuing through the night, read 30·428 the next day. A fall then occurred to 29·959 on the 3rd; after which a very gradual rise ensued up to the 9th, when the reading was 30·593. From this point the readings steadily diminished to 29·601 on the 14th. It remained about the same height through the 15th and 16th; then rose during the 17th and 18th to 30·292. The rise that followed was slower until the maximum reading of the month, 30·646, was recorded on the 24th. During the next two days the barometer went down; afterwards slightly rising, fell on the 30th to 29·894.

The mean height for the month was 30·284 in.

Temperature of the Air.—The curve of mean temperature is not so regular as the barometer curve.

The temperature of the 1st was 51·1°; it fell then very much until the 3rd, when it stood at 36·7°. Between 8 a.m. and noon of that day there was a rapid rise, and the next day the mean was 48·0°. The thermometer was nearly stationary up to the 10th, when it fell, and read 36·3° on the 11th. After this the temperature increased gradually to the 15th, the warmest day in the month, the mean for that day being 53·9°. A decline followed to 37·0° on the 20th, and cold days continued to the 25th. The 26th was warmer, the temperature being 43·1°. The next day was the coldest day during the month; the mean was 35·6°. The thermometer rose slightly the succeeding days, and read 39·2° on the 30th.

The highest maximum temperatures recorded were 60·9° on the

1st, 55·6° on the 14th, and 60·0° on the 15th. The lowest maxima were—11th, 40·1°; 20th, 40·5°; and the 25th, 39·7°.

The minimum thermometer read lowest on the 28th and 29th, when it stood at 25·0° and 22·6°. It recorded 25·9° on the 3rd.

The highest minimum was 47·4° on the 15th. The extent of daily range was greatest on the 3rd, 22·4°; 8th, 22·5°; 14th, 20·6°; and 29th, 21·1°. The variation was least the 11th, 4·5°, and 17th, 4·6°.

At 2 P.M. on the 1st, a sudden fall occurred in the temperature of 7°.

The mean temperature for the month was 41·9°.

Relative Humidity.—The driest days were the 2nd, 5th, and 20th, when the proportion of aqueous vapour was ·65, ·75, and ·72. The mean amount of moisture was exceeded on the 9th, 11th, and 24th, on each of which occasions it was ·99, complete saturation being 1·00.

Rainfall.—Scarcely any rain fell during November, the only recorded quantities were—

2nd, 0·003.	15th, 0·060.
8th, 0·004.	26th, 0·008.

Giving for the month the total of 0·075 in.

Direction of Wind.—

North, 2nd, 6th, 18th, 23rd.

North-west, 1st, 19th, 20th, 21st, and 22nd.

West, 4th, 8th, 26th, and 28th.

South-west, 3rd, 25th, 29th, and 30th.

South, 14th, and North-east, 5th, 15th, 16th, 17th, and 24th.

The velocity was not recorded continuously,

December, 1867.

Atmospheric Pressure.—The last month closed with the barometer falling. It continued rapidly doing so up till 6.30 P.M. on the 1st, when it reached the unusually low point 28·740 inches; after which it rose as quickly as it fell, giving a mean height, on the 1st, of 29·252.

The readings continued increasing up to the 4th, it being then 30·311; the next day it fell to 29·829, remaining stationary to the 6th; then rose steadily to 30·274 on the 9th. The pressure diminished slightly on the 10th, but augmented gradually to the same point on the 13th; then a regular fall set in, which continued up to the 18th, it having descended to 29·510 at that date.

A rise, somewhat interrupted, succeeded, to the maximum height of the month, 30·371, which was attained on the 27th. After this

date the barometer continued high to the end of the month, a slight fall on the 29th alone intervening.

The mean reading of the barometer for the month of December was 30·014 inches.

TEMPERATURE OF THE AIR.—The fluctuations of the thermometer were numerous, and of considerable extent, during the month.

On the 1st the temperature was nearly constant at 54° until 6.30 P.M. At this time, when also the barometer arrived at its lowest point, the thermometer fell suddenly about 5°, and then a rapid continuous fall set in up till 8 A.M. the next day, having reached 28·0; it remained low the whole of that day, the mean being 29·2. The succeeding days were a little warmer, the temperature on the 5th being 38·5; but after this the thermometer gradually went down to 26·5 on the 9th, the coldest day in the month. But a great rise occurred after, it running up to 49·1 on the 12th; falling a little on the 13th, it again rose, and the 15th was the warmest day of the month, the mean being 51·9. At 2·10 P.M. on the 18th, an almost sudden fall of 5° was recorded, and then the temperature went down and read 29·0 on the 20th. It went up again to 50·2 on the 22nd. At 1 P.M. a continuous fall set in, which lasted till 10 A.M. on the 24th, when it was 30·0. It quickly rose to 45·0 at 2 P.M., and remained stationary at that point till noon the next day.

The 26th was another cold day, the mean being 29·3; and the temperature continued low to the end of the month.

The highest maximum readings were 55·1 on the 1st, and 53·7 on the 15th and 16th. The lowest were 31·7 on the 2nd, 30·2 on the 9th, and 31·2 on the 31st.

The lowest minima recorded were on the 0th, 10th, and 20th, these being 21·6, 19·8, and 22·0 respectively. The highest minima were—16th, 49·7; and 17th, 28·1.

DAILY RANGE.—This was greatest on the 24th, when it was 22·5. On the 10th it was 19·0. The extent of range was least on the 2nd, 3·7°, and 16th, 4·0°.

The mean temperature for the month, was 38·3°.

RELATIVE HUMIDITY.—This record for the month is very imperfect, good determinations not having been obtained on several of the days. Of those when it was observed, the 7th, 12th, and 30th were the most dry, being ·76, ·75, and ·77.

The greatest amount of moisture was present on the 22nd and 28th, being ·98 on those days.

RAINFALL.—Several of the recorded amounts fell as snow, and

were melted previous to being measured. Such are marked *. The quantities were as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1...	0·686 inch.	6...	0·010* inch.	15...	0·130 inch.	22...	0·010 inch.
2...	·523* „	7...	·014* „	16...	·105 „	24...	·013 „
3...	·005* „	8 & 9.	·126* „	18...	·005 „	27...	·010 „
5...	·185 „	11...	·005 „	21...	·118 „	30...	·004 „

The total fall during the month being 1·979 inches.

DIRECTION OF WIND.—

Northerly—7th, 9th, 25th, and 29th.

North-West—2nd, 3rd, 5th, 6th, 8th, 11th, 12th, 13th, 15th, 18th, 19th, and 22nd.

West—16th, 17th, 20th.

South-West—1st, 10th, 14th, 21st, 23rd, and 26th.

South—24th.

East—31st.

North-East—27th, 28th, and 30th.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

MONTHLY AND ANNUAL MEANS FOR THE YEAR 1867.

Month.	Barometer, corrected to temp. 32°.	Temperature of Air.	Dew Point.	Relative Humidity.	Daily Range.	Total Fall of Rain.
	inches.	°	°		°	inches.
January	29·649	34·8	(35·8)	·86	12·0	3·373
February	30·030	44·9	39·2	·82	9·9	1·253
March	29·740	37·0	32·0	·83	11·2	1·980
April	29·812	48·5	42·2	·81	14·2	1·625
May	29·899	52·9	43·8	·74	17·6	1·285
June	30·043	57·3	50·2	·80	18·7	1·361
July	29·894	59·6	51·2	·75	17·7	3·606
August	29·584	62·0	53·8	·76	18·0	2·057
September	30·071	56·9	49·8	·79	15·0	2·263
October	29·911	50·0	45·5	·85	14·7	1·615
November	30·284	41·9	37·3	·85	12·4	0·075
December	30·014	38·3	36·8	·88	10·3	1·979
Yearly Means	29·911	48·7	43·1	·81	14·3	22·472

Highest Temperature recorded during the Year......... 85·9° on August 14th.
Lowest ditto ditto ditto .... 1·0° on January 5th.
Greatest Fall of Rain in twenty-four hours............... 1·328 inch on July 25th.

ASTRONOMICAL NOTES FOR FEBRUARY.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

It is no less pleasing than profitable, in our progress up the ascent of science, sometimes to pause and contemplate the appearance presented by the stand-point at which we have arrived, thereby invigorating ourselves by the prospect of the results already achieved, and deriving well-founded hope for the triumphs yet awaiting the labours of the patient and intellectual observer of the facts of nature. Perhaps this is at least as much the case in the science of astronomy, the oldest and most perfect of them all, as in any other. There is a tendency to imagine that when a vast body of facts has been so formed, as it has here, into a coherent whole, that the mutual support of each part—according to the well-known remark of Bacon—gives an enduring strength to the theory containing all, there no longer remains anything to be accomplished, save to fill in some minor details, and to discover some less important residual phenomena. The truth appears to be better represented by the analogy of the erection of a firm and solid foundation, which enables us fearlessly to add a higher and higher superstructure, and, also, availing ourselves of other firm foundations when they lie at hand, or are afterwards acquired, in the shape of well-established theories in other sciences, to erect, upon a united basis, still nobler and more extensive edifices. Of course it follows that the broader and larger is our foundation, the more material will be required for the superstructure. Hence does it arise that as science advances, she more and more eagerly welcomes a larger and ever-increasing accession of workers into her ranks, and provided they be really earnest students of nature, and careful observers of facts, has abundance of well-repaying employment for all who are able to enlist themselves in any degree into her service.

When Heis, Quetelet, Glaisher, Greg, and a few others, some years ago, commenced laboriously recording the places and paths of all the meteors of which they were able to obtain observations, who could have anticipated that physical astronomy would be able, in 1866-7, to apply the resources of mathematical analysis to these

wayward bodies, and to show that at least one group of them, obeyed the laws of planetary motion, and appeared periodically in consequence of its motion round a very eccentric ellipse? No time was left us to speculate on the mere analogy here presented with the motions of comets; we were startled at the same time to learn that the path of this group was nearly if not quite identical with that of a small comet. Thereby new conjectures were immediately suggested, and zest is given for further and still more assiduous observation of all kinds of meteors. The coincidence, if it be only coincidence, has been also shown in two other groups of meteors, and it is to be hoped that this year will enable us to acquire some new facts connected with this interesting subject.

When Wollaston, more than half a century ago, noticed dark bands in the solar spectrum, who could have dreamed that the remark was the forerunner of those wonderful discoveries so recently obtained concerning the actual chemical constitution of not only the Sun, but even of the more distant fixed stars, and still more distant nebulæ? The labours of Mr. Huggins lead us to hope that some light may be thrown in this way upon what we should think of such strange speculations as the nebular hypothesis. Well may we hope that the year 1868 will not be barren of results in this subject also.

The year 1866 was remarkable for the rare phenomenon of the sudden outburst of a star, which, previously quite telescopic, became distinctly visible to the naked eye; so much so as to completely change the apparent shape of the constellation, Corona, in which it was situated. It will be desirable to keep a look-out upon this star, with the view of ascertaining whether it undergoes any further changes. Its place is R.A., 15h. 54m. 0s., N.P.D. 63° 42′; whilst that of ϵ Coronæ, the bright star near it, is R.A. 15h. 52m. 7s., N.P.D., 62° 44′. Some other discoveries of a like, but less startling kind, made by Julius Schmidt, the indefatigable Director of the Observatory at Athens, have afforded additional proof that naked-eye astronomical observations are still sometimes productive of good fruit.

Although much more might be said of the future prospects of astronomy, both in reference to matters which, now but mere conjectures, may, in accordance with previous analogy, become ere long ascertained facts, and in reference to what may be hoped for from the laborious exertions of established observatories, which are even now enlarging our knowledge of parts of the universe beyond our own solar system, yet we must rather pass on to the more

immediate subject of the present paper—the suggestion of suitable objects for general observation in the month of February, 1868.

Planets of the Month.—Saturn will be a beautiful object in the early morning hours, but will, throughout the month, not rise until considerably after midnight. About half an hour before rising on the morning of the 16th (that is, at twenty-three minutes before two o'clock), it will be in conjunction with the Moon.

Jupiter will be visible in the early evening, but low in the heavens, so that scarcely any of the phenomena of his satellites will be seen, and none possessed of any particular interest. In the latter half of the month he will set soon after six o'clock.

Mercury will be tolerably well situated for observation, as he will be at his greatest elongation on February 20; and, as he will then be approaching inferior conjunction, he will afterwards appear horned. At the beginning of the month he will set about half-past five, at the end of it not till nearly half-past seven. On the 24th and 25th he will be very near the Moon, being in conjunction with her about midnight on the former day.

This planet is seldom seen with the unassisted eye, from its being only visible at certain times, and then usually very near the horizon. Yet it shines with an intense light, and bright white colour, and is at times, between greatest elongation and inferior conjunction, very conspicuous. Indeed, in large telescopes (as is also the case with Venus), when seen after sunset, it is requisite, in order to obtain good definition to observe with a slightly coloured glass, to take off the glare of the light. It reflects great credit upon the diligence of the ancient Greek astronomers that they observed this planet so frequently as they did. Riccioli made use of the expression, that the celestial Mercury was as slippery a customer for astronomers as the terrestrial mercury (quicksilver) for chemists and alchemists. And it is well known that the great Copernicus regretted on his death-bed, that, notwithstanding all his efforts, he had never once succeeded in seeing it.

It is somewhat singular that nearly all our knowledge of this body is derived from the observations of Schröter, at the beginning of the present century. He, and his assistant Harding, noticed changes in the brightness of particular parts of the surface, which were probably due to variations in the clouds upon it, and therefore indicated the existence of an atmosphere, the possible means of tempering the intense glare of the sunshine. A periodical blunting or thickening of the southern horn appeared to suggest the presence of mountains, of a height which they estimated at nearly eleven

miles, and afforded a means of estimating the time of the planet's rotation on its axis, which they considered to be about 24h. 5½m. It would be extremely desirable to obtain some confirmation of these results. But few persons have courage or patience to attempt it.

VENUS is gibbous throughout the month. At the beginning of it she sets about a quarter to eight; at the end, a little before nine. At a quarter past four on the afternoon of the 26th, she is in conjunction with the Moon, and is then only 3° 11′ north of that body.

Venus is, to use Sir John Herschel's expression, the most difficult of all the planets to define with a telescope. The existence of an atmosphere nearly equal to our own in density and height has been clearly proved. An alteration in the appearance of the south horn, similar to that of Mercury's, has been noticed. The time of rotation has been formerly a matter of dispute, but Schröter, by long and patient observations, was able to trace the motions of spots, which gave a time of about 23h. 21m. This has been well confirmed by the observations of De Vico at Rome, who, observing these spots in the day-time, was led to a time which may be supposed pretty exact. It amounts to 23h. 21m. 23s. These spots are extremely difficult to see, yet, in peculiarly favourable conditions of our own atmosphere, may sometimes be much less so; so that, as is observed by the Rev. T. W. Webb, in that invaluable book for amateurs, "Celestial Objects for Common Telescopes," "the possessors of even common telescopes need not despair, though their chances may not be great." The appearances of the southern horn already mentioned have been supposed to prove the existence of mountains of a height very considerably exceeding that of the highest elevations on the earth.

OCCULTATIONS OF STARS BY THE MOON are often very interesting phenomena. We annex a table of those which will be visible during the month before one o'clock in the morning. They are five in number, as follows; M. denoting the magnitude of the star, and V. the angle from the highest point, or vertex, of the Moon, counting round to the right hand in an inverting telescope, at which the disappearance and reappearance respectively take place.

OCCULTATIONS OF STARS BY THE MOON.						
DAY.	NAME OF STAR.	M.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
Feb. 4	130 Tauri	6	6 57	33	7 53	303
„ 6	5 Cancri	6	10 42	41	11 39	311
„ 8	A Leonis	5	12 3	13	12 51	299
„ 28	μ Ceti	4	9 25	75	9 48	29
„ 29	*f* Tauri	4	5 25	57	6 5	3

Star Observations.—Our space scarcely admits of any remarks on star-observing this month. We will content ourselves, therefore, with remarking, that, about the middle of the month, the sidereal time at six o'clock in the evening will be 3h. 40m.; and that, therefore, all objects of Right Ascension greater than that, and less than ten hours, will be readily observable in the evening throughout the month. The season is usually the most favourable one for observing double, triple, etc., stars, star-clusters, and nebulæ. Of these, very useful working lists will be found in Book VI. of Chambers's "Descriptive Astronomy."*

The Moon.—February 1. First quarter at 6h. 15m. P.M. Plato near the north point. Nearer the centre, Eratosthenes and Stadius. Beyond these the remarkable formation, called Schröter, by its discoverer Gruithuisen. Near the south point, Tycho. To its north is the Mare Nubium.

February 2. This evening Copernicus (fifty-six miles in diameter), will be on the terminator. The region between this and Eratosthenes is remarkable for a very large number of minute craters. To the north of Copernicus lies Mare Imbrium.

February 4. Kepler will be in view. South of it the distinctly green Mare Humorum.

February 5. Aristarchus in view. Curious variations in the light have been noticed: a subject quite recently again called attention to by Herr Tempel.

February 8. 9h. 35m. A.M. Full Moon. The Mare Crisium, a conspicuous dark grey plain, with an occasional trace of green,

* A New Edition of Mr. Webb's excellent work is in the press.

may be profitably observed about this time for colours, tints, and visibility of its numerous objects.

February 23. 2h. 20m. P.M. New Moon.

February 25 and 26. The terminator will pass over the Mare Crisium and Mare Fœcunditatis.

February 27. Over the Mare Tranquillitatis and Mare Nectaris. Beyond the latter, to the north-east, is the large and very deep crater Theophilus, with central peak 5200 feet high.

February 28. Posidonius, a remarkable walled plain, sixty-two miles across, bounding Mare Serenitatis on the west, will come into view late in the evening.

February 29. The terminator will pass over that M. Serenitatis, in the north-western quarter of the Moon. It contains, besides Bessel and Sulpicius Gallus, the remarkable little crater Linné, or Linnæus, about which there has been so much discussion during the past year. Beyond the Mare, is the magnificent range of the Lunar Apennines, some of the ridges and peaks of which will come into view during the night.

STORMS AND HURRICANES: THEIR MOTIONS AND CAUSES.

BY HENRY WHITE, PH.D.

It is a common, and, we believe, very erroneous opinion, that the elemental catastrophes of recent years have been more severe and destructive than those of past times. The error is easily explained. By means of the electric telegraph, and our rapid steam communication, the news is conveyed so quickly to us, that we almost seem to be present at the scene of disaster, and therefore realize it more vividly. It is, as it were, almost next door to us. But a few years ago, the tidings of an earthquake or of a hurricane travelled slowly, and the general public regarded it "as a sorrowful tale long past." Severe as was the "Royal Charter" gale of 1859, it did not probably exceed in violence that of November, 1703, which fell under the observation of Derham, and was described by him in the twenty-fourth volume of the "Philosophical Transactions," and by Defoe, in his account of the Great Storm. The year had been remarkable for the excessive humidity of the spring and summer months, and particularly of May, when more rain fell than in any

month of any year since 1690; and, although the wetness of the season may have had nothing to do, immediately, with the storm, it must, in some degree, have affected the atmospherical conditions of the country. On the 25th of November the wind began to rise; on the 26th its fury augmented, "until at midnight," says Derham, "the storm awakened me. It gradually increased until near three in the morning, and continued until seven with the greatest violence." The storm swept over all England south of the Trent, marking its course by disasters rarely exceeded in tropical climates. Oldmixon describes its doings in London:—"The wind blew west-south-west, and grumbled like distant thunder, accompanied with flashes of lightning. It threw down several battlements and stacks of chimneys at St. James's Palace, tore to pieces tall trees in the Park, and killed a servant in the house. A great deal of lead was blown off Westminster Abbey, and most of the lead on the churches and houses was either rolled up in sheets or loosened." Among the more distinguished victims of this elemental strife were "that pious and learned prelate, Dr. Richard Kidder, Bishop of Bath and Wells, and his lady, who were killed by the fall of part of the old episcopal palace at Wells. The Bishop of London's sister, the Lady Penelope Nicholas, was killed in like manner at Horsely, in Sussex, and Sir John Nicholas, her husband, grievously hurt." The number of undistinguished victims who lost their lives, at sea and on shore, during this tempest, has been computed at more than eight thousand. Three hundred sail were wrecked upon the coast; nine hundred wherries and barges destroyed on the Thames; Rear-Admiral Beaumont, with the crews of several ships, perished on the Goodwin Sands; and the Lighthouse at Eddystone, built by Winstanley, was swept away, along with its builder, so that not a fragment was ever found again. One hundred churches were unroofed; four hundred windmills and eight hundred houses blown down; a quarter of a million of forest and fruit-trees levelled with the earth; and fifteen hundred sheep and cattle drowned by the overflowing of the Severn. The whole nation was for a moment prostrated with terror: many fanatics thought the last day had come—they even imagined that they had heard the trump of the archangel in the blast; and it was many a long year before people could speak of the Great Storm, or of Black Friday, without a shudder.

This visitation of November, 1703, was, in common language, a storm or a tempest—by which is loosely signified a fierce wind blowing in one direction without shifting (as here, from south-west

to north-east); but, from the few scattered observations we have been able to discover (such as the shifting of the wind from S.W. to N.W.), there seems reason to believe that this November storm was in reality part of a hurricane or cyclone. It had probably originated in the usual birth-place of the cyclones, and followed their customary direction until, in the middle of the Atlantic, the centrifugal force proved too strong: it flew asunder—as we have seen the tire of a fly-wheel separate, one portion going off we know not where, the other flying in a tangential line to its original course—to dash with unrestrainable violence upon our shores.

Turning to the more immediate subject of this paper, we shall begin with a description of two of the most tremendous visitations of physical power that have ever been let loose upon our globe. They both occurred in October, 1780, and are amply recorded by Colonel Reid in his "Attempt to develope the Law of Storms," published in 1838. The first happened on the 3rd October, when, after the fury of the tempest had abated, the waves rose to an amazing height, and rushing with indescribable impetuosity on the shore, swept away the town of Savannah-la-Mar, in Jamaica. At Montego Bay, prodigious flashes of lightning regularly succeeded each other, lighting up the midnight darkness which brooded over the general desolation. A still more furious hurricane burst forth on the 11th October. At Barbadoes, the inhabitants were driven from their houses, and forced to seek what shelter they could find in the fields during the night, exposed to all the fury of the elements. A ship was dashed on shore against one of the buildings of the Naval Hospital, and the bodies of men and cattle were lifted from the ground, and carried many yards. Trees were uprooted, all the fruits of the earth were ruined, and more than three thousand of the inhabitants destroyed. At St. Eustatia, seven ships were beaten to fragments on the rocks, and their crews lost. In the night of the 10th, every house to the northward or southward was blown down or washed into the sea, a few only escaping. In the afternoon of the 11th, the wind shifted suddenly to the eastward, and at night it blew with such fury as to sweep away every house. Six thousand people were destroyed, mostly by drowning. At Port Royal, one thousand four hundred houses, besides the churches and public buildings, were blown down; and about one thousand six hundred sick and wounded were almost all buried in the ruins of the hospital of Notre Dame. At the town of St. Pierre, in Martinique, every house was blown over, and more than one thousand people perished. At Barbadoes, though the walls of the Govern-

ment-house were three feet thick, and the doors and windows had been barricaded, the wind forced its way into every part, and tore off a large portion of the roof. The governor and his family retreated to the cellar, which they were compelled to leave on account of the entrance of the water. They then fled for shelter to the ruins of the foundation of the flag-staff, and when these gave way also, the party dispersed. The governor and the few that remained were thrown down, and with difficulty reached the cannons, under the carriages of which they took shelter. Many of the guns were thrown down by the fury of the gale, and they dreaded every moment either that those over their heads would be dismounted, and crush them by their fall, or that some of the flying ruins would put an end to their existence.

The Barbadoes hurricane of 1831 was another peculiarly calamitous visitation, destroying the lives of one thousand four hundred and seventy-seven persons in the short space of seven hours. At St. Vincent's, one of the inhabitants noticed a cloud to the northward of so threatening an aspect, that he had never seen anything like it during his residence of forty years in the tropics: it was of an olive-green colour. He hastened home, and by nailing up his doors and windows, saved his house from the general calamity. The water of the sea was raised to such a height in Kingston Bay as to flood the streets. The waves broke continually over the cliffs at the north point, a height of seventy feet, and the spray was carried inland by the wind for many miles, and in such quantities that the fresh-water fishes in the ponds were killed. At Barbadoes, the storm was ushered in with variable squalls of wind and rain, and intervening lulls. About five o'clock in the afternoon of the 10th August, a dismal blackness gathered over everything, with the exception of an ominous circle of obscure light towards the zenith. Shortly after midnight, the paroxysm of the storm occurred, the wind shifting from the north-east to the north-west. Incessant flashes of lightning illuminated the upper regions; but, says an eye-witness, the editor of the "West Indian," "the quivering sheet of blaze was surpassed in brilliancy by the darts of electric fire which were exploded in every direction. A little after two, the astounding roar of the hurricane cannot be described by language. At intervals the lightning flashes ceased, when the blackness enveloping the town was inexpressibly awful. Fiery meteors rained from the heavens; one in particular, of globular form and deep red hue, fell sheer down, growing white hot (as it were) in its descent, and elongating as it neared the earth,

against which it dashed, splashing its fiery fragments all around, as if it had been a mass of melted metal from the furnace. Now followed a brief silence, during which the wind fell to a distant roar. The clouds sank so as nearly to touch the houses; flaming streams of electricity poured downwards, and were returned in rapid succession upwards from the earth, resembling the quick, irregular discharge of opposing artillery closely engaged. Again the storm burst forth, and with increased violence, hurling before it thousands of missiles, the fragments of every unsheltered structure of human art. The strongest houses shook to their foundations, and the surface of the earth trembled. No thunder was at any time distinctly heard; it was probably drowned by the horrible roar and yelling of the wind, the noise of the sea, and the crash of falling roofs and walls." The rain (or spray) was driven with such violence as to injure the skin. At daybreak, when the storm had considerably abated, the prospect was "majestic beyond description." "The gigantic waves rolling onwards, seemed as if they would defy all obstruction; yet, as they broke over the careenage, they seemed to be lost, the surface of it being entirely covered with floating wreck of every description. It was an undulating body of lumber—shingles, staves, barrels, trusses of hay, and every kind of merchandise of a buoyant nature. Two vessels only were afloat within the pier, but numbers could be seen which had been capsized or thrown on their beam-ends in shallow water." The whole face of the country was laid waste; no sign of vegetation was apparent, except here and there small patches of a sickly green. The surface of the ground appeared as if fire had run through the land, scorching and burning up the productions of the earth.

In 1837, at the island of Tortola, (the same which was reported to have been submerged in the hurricane of last October), thirty-six vessels were wrecked, and more than one hundred seamen drowned. Some houses were turned bottom upwards, and one large, well-built house was torn from its foundations, and carried upright into the middle of the street. The fort at the entrance of the harbour was levelled with the ground, and the 24-pounders were thrown down Governor Rumbold, describing the effects of the recent hurricane, says: "The face of nature, as by a miracle, was transformed; it appeared as if winter had visited the tropics; for the few trees that stood, and all vegetation, were withered by the desolating blast." These illustrations being sufficient to give an idea, though it may be a faint one, of the horrors of a West Indian hurricane, we shall next bring together some special phenomena, and

then endeavour to explain the modern theories on the subject.

The light in the zenith, observed at Barbadoes, was also noticed during the Antigua hurricane of July, 1837, by the captain of the "Judith and Esther":—"The wind was blowing fresh from the N.E., when I observed near the zenith a white appearance of a round form, and while looking steadfastly at it, a sudden gust from the N.E. carried away the topmast and lower studding-sails." There are other instances of this curious phenomenon, when the wind appears to stoop like a bird of prey. They are probably connected with the gyratory motion of the air, and may be compared to the little whirls that may be observed on water, occasionally darting off erratically from some larger whirl; or to the tiny eddies that play fitfully about on a hot summer's day, as if a troop of atmospheric fairies were amusing themselves. In tornadoes (which we may call concentrated hurricanes), the roof has been torn off one house standing among many, the rest of the house being untouched. Trees in a grove have likewise had their tops cut clean off, while others to the right and left have been uninjured. The description of the "white spot" seen at Barbadoes (the wind blowing from the northward) appears to support the gyratory explanation:—"It remained at rest for a very few moments, when the scud of it was to be seen in a state of ebullition. The dense mass of clouds all around was agitated, and separating bodies of it were quickly dispersed to all points of the compass." During the "Royal Charter" gale of October, 1859 (which was a cyclone), this strange light in the zenith was observed at Holyhead. "About seven P.M.," (says an eye-witness), "I was startled by what appeared to be a bright belt of fire directly over my head, the light of which was intense. It pierced through the heavy mass of vapour which obscured the heavens, and illuminated the whole bay and land with the light of day. This meteor (?) lasted from two to three seconds. Very soon after this the wind increased to a hurricane." The luminosity of this meteor and the obscurity of the Barbadoes "circle of light," may be accounted for by the fact, that one was seen by night, the other by day.

The peculiar noise of the wind is another striking characteristic of the hurricane, as well as the impenetrable darkness by which it is sometimes accompanied. One seaman speaks of the hurricane bursting out afresh "with the most tremendous, unearthly screech he had ever heard." Another describes the wind as "representing numberless voices elevated to the shrillest tone of screaming."

This furious screaming, heard alike at sea and on shore, deserves more notice than it has hitherto received. The captain of the "Duke of Manchester" says: "A most remarkable phenomenon presented itself to windward almost in an instant. It resembled a solid black perpendicular wall, about 15° or 20° above the horizon, and it disappeared almost in a moment. It then reappeared as suddenly, and in five seconds was broken, and spread as far as the eye could see." "This black squall," continues Mr. Griffiths, "was the most appalling sight I have ever witnessed." One of the officers of H.M.S. "Tartarus," which was caught in a hurricane off the American coast in September, 1814, says, that after the tempest had continued for four hours with a mountainous sea, the barometer sank beneath the wood of the frame, and the scenery of the sky became indescribable. "No horizon appeared, but only something resembling an immense wall within ten yards of the ship." Captain Macqueen, of the "Rawlins," speaks of a "dismal appearance" seen at the N.W., which seems to be the "black wall" of other navigators. Perhaps connected with this phenomenon may be the following extract from the log of the "Castries," from Liverpool, in N. lat. 15° 4′; W. long. 54° 58′. "Land was discovered on the lee bow, having the appearance and broken outline of a West Indian island." The captain prepared to alter his course, when on looking again, the supposed island had vanished. He afterwards heard of the hurricane of Santa Lucia (July, 1837).

Very remarkable electric phenomena accompany most hurricanes. Some have been described already, but the following belong to quite another order of facts. Captain Seymour, of the "Judith and Esther," says:—"For nearly an hour we could not observe each other or anything, but merely the light (lightning?), and, most astonishing, every one of our finger-nails turned quite black, and remained so nearly five weeks afterwards." In the Barbadoes hurricane of 1831, a large portion of the trees in a forest at St. Vincent's were killed without being blown down. Colonel Reid, who frequently examined them, is of opinion that they were destroyed by the extraordinary quantity of electric matter rendered active during the storm. At Barbadoes, during the paroxysm of this very hurricane, two negroes were greatly terrified by sparks of electricity passing off from one of them, as they were struggling through the garden of Coddrington College to a place of shelter. In some well-authenticated reports of tornadoes, sparks have been seen to issue from the sand as it was driven through the air. Lieutenant Spey describes another peculiarity of electricity when in very energetic

action, though somewhat similar manifestations have been witnessed in the monsoon storms:—"Every flash of lightning," he says, "was accompanied with an unusual whizzing noise, like that of red-hot iron plunged in water."

It is still a question whether hurricanes are accompanied by earthquakes or not. In the hurricane of 1780, when Savannah-la-Mar was destroyed, after the waters began to abate, a most severe shock of an earthquake was felt. Writing about Barbadoes, Sir George Rodney says in his official despatch that "Nothing but an earthquake could have occasioned the foundations of the strongest buildings to be rent;" and he was convinced that "the violence of the wind must have prevented the inhabitants from feeling the earthquake, which certainly attended the storm." The logic is not conclusive, but the science of meteorology teaches us in what manner it is possible for the surface of the earth to be affected during a hurricane, so as (at least) to produce the great oceanic waves that so often accompany the tempest. During the late hurricane at Tortola the barometer suddenly fell two inches—equivalent to a decrease of pressure represented by one pound avoirdupois. One pound per square inch is over one and three-quarter million (1,792,183) tons per square mile. Is it possible for the earth to remain unaffected by the removal of this pressure? The apparently firm surface upon which we tread is in reality but a thin crust spread over a fiery incandescent gulf below, where all kinds of volcanic action are at work and pent-up gases struggling to find a vent. When the pressure of the atmosphere is removed, these gases would force the crust upwards, displacing the foundations of buildings and toppling down the summits of mountains. The earth trembles, not from the fury of the blast, but from the motion communicated to the surface from beneath. This upheaval and subsidence is always going on over the whole superficies of the globe; but what takes place slowly in obedience to slow barometric changes, in the hurricane may take place violently in proportion to the rapidity of the barometric fall. We would not lay too much stress upon this theory, but it appears to be at least worthy of investigation. It seems confirmed by a curious circumstance not unfrequently noticed, especially in tornadoes, namely, the bursting of doors and windows outwards from within—a phenomenon apparently the result of a sudden diminution of atmospheric pressure on the outside of the building. It has also been noticed that when the ridge of a house runs at right angles to the direction of the wind, the windward slope remains uninjured, or almost so, while the leeward or unexposed

slope is utterly destroyed. Perhaps both phenomena may be explained on the same principle. We may suppose the windward slope to be kept in its place by the pressure of the blast, while the leeward slope is destroyed by the rarefaction of the air. Says Professor Loomis:—"A current of air forcibly impelled over an obstacle like the roof of a building, by friction drags along with it the air lying upon the leeward side of the roof, producing a partial rarefaction, which might easily be sufficient to lift the roof." The rarefaction required to produce this effect is much less than might be imagined. Supposing a barometer above the roof to show a fall of only one-tenth of an inch lower than within the building, there would be an upward force of seven pounds per square foot, quite sufficient to throw off the roof of a barn or stable.

Attempts have been made to calculate the velocity of the wind in a hurricane, but as yet the results are extremely vague and unsatisfactory. "The blast struck us like the discharge of a cannon," says one seaman. "During the heaviest of the gale, the sea was smooth," says another. "The wind was so strong that it beat down the waves." Other witnesses add: "The tops of the waves were quite cut off. The sea-drift flew across the deck with such fury that no one could withstand its force." In the hurricane of 1825, by which Basseterre in Guadaloupe was destroyed, three 24-pounders were blown away, and a piece of deal, 37 inches long, nine inches wide, and seven-eighths of an inch thick was driven through a palm-tree, 16 inches in diameter. In a whirlwind felt at Calcutta (April 8, 1833), a long bamboo cane was forced through a wall five feet thick, so as to pierce the facing of the wall on both sides. The editor of the "Indian Review" remarks that a 6-pounder gun could hardly have produced the same effect. At Santa Lucia in 1780, cannon were carried more than a 100 feet. Some extraordinary stories (which need confirmation) are told of the force exerted by the wind at St. Thomas's during the hurricane of last October. The signal gun on the ramparts was forced through the parapet wall. A diving bell, a bulk of about nine tons, was lifted and carried away nearly a quarter of a mile. A piece of scantling, 25 feet long, was driven through the roof of a house, through the back of a rocking-chair, and then through the floor, resting on the counter of the shop underneath. Stranger still, a stone, supposed to weigh 40 tons, was so moved that it had a ship's sail spread under it, "much in the same way as a table-cloth would be laid on a table with a large dish-cover set in the middle."

In the Stow Tornado of 1837, and in that of New Haven, 1839, several fowls were picked up almost stripped of their feathers. A similar thing was noticed at Mayfield in 1842. Professor Loomis supposes this new mode of plucking geese to have been effected by the velocity with which the birds were driven through the air; and from a curious but rough experiment made with a 6-pounder, he concludes that a speed of 100 miles an hour would be sufficient to strip off the feathers. After this, we almost feel inclined to take seriously the old "yarn" of the wind blowing so hard, that it swept all the hair off one man's head, and turned the head of another half way round. In the great storm of December, 1852, which will be fresh in the recollection of many readers, the velocity of the wind was calculated at 57 miles an hour. In the "Royal Charter" gale of October, 1859, the wind reached a maximum varying at different places of 60 to 100 miles an hour.

Smeaton estimated the utmost pressure of a hurricane at 46 lbs. to the square foot, and this (though practically considered much exaggerated) was the standard adopted by Stephenson in his calculations for the lateral rigidity of the Menai tube. But there seems to be good reason to believe that the maximum is far higher. On the 18th June, 1839, a considerable portion of a park wall at Chatenay, 6 feet high and 18 inches mean thickness, was thrown down bodily, as if turning on a hinge, and from observations made on the spot shortly after, it is possible to estimate numerically the force necessary to produce such an effect. If we suppose a to represent the vertical height, b the length, and c the thickness of a wall whose transverse section and base are rectangular, w being the weight of a cubic foot of masonry, the moment of resistance to rupture will be represented by $\frac{1}{2}\, a\, b\, c^2\, w$. Again, if p is the pressure per square foot, the force brought to bear against the wall is expressed by $\frac{1}{2}\, a^2\, b\, p$. Equating these expressions, we have $p = \frac{c^2\, w}{a}$. Now if we take $c = 1.5$ ft., $a = 6$ ft., and $w = 222$ lbs.; then $p = 83$ lbs. But by neglecting to take into account the adhesion of the mortar, we have a result far below the truth; and to correct this, we will employ Navier's formula ("Leçons de Mécanique Appliquée," pp. 70, 73), where $p = \frac{R\ c^2}{3\ a^2}$. According to Vicat, the worst mortars give a resistance of (roughly) 2080 lbs. the square foot. Assuming this value for R, then $p = 44$ lbs. nearly. Adding, therefore, this new value to the power, the force exerted against certain parts of the overthrown wall must have

been at least 83 + 44, or 127 lbs., at the moment when the wall fell. This result, which is probably far below the truth, may be explained if we suppose that, during the passage of the whirlwind, a vacuum was formed on the lee of the wall, towards which the air rushed with a velocity partly due to atmospheric pressure, which, in round numbers, we may take at 2200 lbs. per square foot—more than sufficient to produce the effect described. The velocity of the wind sufficient to produce a pressure of 127 lbs., amounted to 135 feet in a second, or 92 miles an hour.

We reserve for another opportunity our discussion of the causes, motions, and paths of cyclones, as well as their periodicity and other matters connected with their dynamics.

ARCHÆOLOGIA.

The city of Bath occupies the site of one of the most fashionable towns of Roman Britain. It was called by the Romans *Aquæ Calidæ*, literally the warm baths, and *Aquæ Solis* the baths under the auspices or protection of the sun (taking the sun as a deity); for at this early period it was as celebrated for its baths as in modern times. Traces of magnificent temples, the principal of which is said to have been dedicated to Minerva as the patron goddess of the place, have frequently been met with in digging, and inscriptions found there at different periods show that military commanders, high municipal officers, and other persons of rank, frequented this city for the benefit of its waters, and probably, also, to mix in its fashionable society. Some very recent excavations have brought to light further relics of the Roman city and of its people. These excavations have been made upon a site rather celebrated in the antiquarian annals of the modern city—that of the old White Hart Hotel. Older excavations, made in the latter years of the last century, at the top of Stall Street, near the White Hart, brought to light remains which appeared to be those of part of a vast temple, and which were supposed to be those of the famous temple of Minerva. They are described as lying on the eastern side of the great Fosse road, which ran through the Roman town from north to south, and about the middle of the town. The temple fronted the west, the front consisting of a portico supported by very large fluted columns of the Corinthian order, crowned with rich sculptured capitals. The architraves bore inscriptions to the Deæ Campestres, well-known local objects

of Roman worship, and to other local deities, and the frieze was enriched with gigantic images, figures of animals, and groups of foliage. These facts we learn from Collinson's "Antiquities of Somerset," published in 1791. A portion of the frieze of the great temple thus discovered has been preserved in the Museum of the Bath Literary and Scientific Institution; the continuation of this frieze has been found in the recent excavations. The basement of a large building has also been traced, and the excavations have laid bare a sort of concrete pavement, which, from its character and extent, leads to the inference that there had been a large area or parade-ground adjoining the temple. In the year 1755, the foundations of the splendid Roman baths were found at a depth of twenty feet beneath the modern surface of the ground, at a little distance to the east of—that is, of course, behind—the temple of Minerva just mentioned. The recent excavations have also been carried to a great depth; and they passed through eighteen inches of red clay largely impregnated with iron, which is supposed to have been the sediment of the Bath waters. Immediately above this clay the foundations of the Roman period were found.

While speaking of Bath, we may refer to a recent publication of the Camden Society, a sort of antiquarian journal of Thomas Dingley, who lived in the reign of Charles II., under the title of "History from Marble." Dingley's journal is especially full on the city of Bath, and, among many other things, it contains descriptions much fuller and more correct than those we previously possessed of many Roman monuments now lost, and of a few which were not previously known. At that time it appears to have been quite common to find stones with Roman inscriptions or sculptures in the walls of the houses, etc., of Bath, and more especially in the town-walls, and he has preserved the fragment of an inscription of one of those which was then visible in the wall between the north and east gates of the city, consisting of the following words:—

DEC · COLONIAE GLEV ·
VIXIT AN · LXXXVI ·

It is part of a sepulchral monument to the memory of a *decurio*, or member of the *curia*, or senate, of the city of *Glevum* (Gloucester), who had lived, at the time of his death, eighty-six years. It is commonly supposed that the climate of Britain was not favourable to the health of the Roman colonists, but here is a municipal officer of Roman *Glevum* who had reached the age of eighty-six, and, even at that advanced age, had gone to seek restoration of health, for he could hardly have been in search of fashionable

society, in the baths of *Aquæ Solis*, and to leave his bones there.

At the time of the meeting of the British Archæological Association at Ludlow, in the beginning of August last year, an interesting discovery was made at BROADWARD in that neighbourhood, which has not yet been noticed in print. Broadward is in the parish of Clungunford, and both it and the village of Clungunford are close upon the line of the Roman road, and at each there is a fine tumulus, or barrow, no doubt of the Roman period. At the date of which we are speaking, some diggings were in progress for the purpose of draining a piece of swampy land at Broadward. In the course of their work, the drainers came upon a very large deposit of spear-heads, swords, axes or chisels (commonly called celts), knives, and other implements, made of bronze, a portion of which were only disinterred, and these amounted, we believe, to upwards of a hundredweight. This belongs to a class of discoveries which have been very numerous in this country, and the objects thus found, were no doubt the stock-in-trade of a manufacturer of such articles; probably an itinerant manufacturer, who moved from place to place, making and selling. We believe in every case, or at least with very few exceptions, these deposits are met with in the immediate neighbourhood of Roman stations, or Roman roads, as in the case of which we are now speaking, and we feel no doubt in ascribing them to the Roman period. A small quantity of pottery was found with these remains at Broadward, the forms of which, to judge by some rude sketches sent us, are decidedly Roman in character; but we hope, on a future occasion, to be able to give more minute details. A remarkable circumstance connected with this discovery is that the bronze has undergone a considerable degree of decomposition, arising no doubt, from the character of the ground and the water in which they have so long lain, in consequence of which many of them were found compressed together into solid masses. The sockets of the spear-heads, formed to receive the ends of the shafts, appeared at first sight to be filled with something like iron ore, but it turned out on examination to be merely a formation from the decomposition of the bronze.

While speaking of LUDLOW, and of BRONZE IMPLEMENTS, it may be well to remark, that a very interesting collection of these objects, found in 1862, in a field near Guilsfield, in Montgomeryshire, known by the name of "The Camp," are preserved in the museum at Ludlow. Guilsfield is a village at the foot of the hills some three miles to the north by west of Welshpool, and a little to the south of

extensive hill-entrenchments called Gaer-Fawr; we believe that this name *gaer* or *caer*, derived directly from the Latin *castrum*, will be found always to indicate a Roman site, as is the case in England with the word *chester*, derived from the same origin. This hill-station, as well as "The Camp" field below, were probably Roman positions connected with the extensive copper and mining operations carried on by the Romans in this district. Some of the bronze objects found in "The Camp" field, as mentioned above, were described by Mr. Samuel Wood, F.S.A., of Shrewsbury, in a notice printed in the "Proceedings of the Society of Antiquaries of London," on the 16th of April, 1863, and these may now be seen, as stated above, in the local museum at Ludlow, to which we believe they were presented by the Earl of Powis. They consist of fragments of swords, the end of a sword sheath, spear-heads, "celts," and two ferules, all of bronze. The last-mentioned objects present a character which can hardly be other than Roman.

A somewhat extravagant degree of importance has recently been given to the discovery of a polished STONE HATCHET near MALTON, in Yorkshire. It is well known that Malton, or rather Old Malton, on the opposite side of the river Derwent, is the site of a Roman town, in all probability that which was called *Derventio*. It appears that a labourer was digging gravel from the oolitic beds near Malton, when he found this stone implement at, he said, a depth of about nine feet, but, as no notice was taken of it till two or three days after it was found, we cannot rely on the strict accuracy of this statement. This object subsequently fell into the hands of a gentleman who considered it of so much importance, that full-sized photographs were made of it, as well as a view of the gravel beds, and supplied to various parts of the country. We are further informed that more recently a half-fossilized bone, presumed to be part of the leg-bone of an ox, has been found in the same gravel beds.

The Yorkshire papers inform us of interesting discoveries made in November last in a field in the township of AMOTHERBY in the parish of Appleton-le-Street, some four or five miles from Malton, which seems to indicate the former existence of a large ROMAN VILLA on that spot. The discovery was the result of mere accident, which is the more remarkable as the Roman pavements appear to have lain in some places hardly more than six inches below the surface of the ground, and nowhere more than two feet and a half. These pavements are all of considerable extent, indicating a series of very large rooms, though no remains of the walls have yet

been found. These had perhaps been rooted up at some remote period for the sake of materials. One of the pavements is stated to be a hundred and fifty feet across, and must have been that of a court. The construction of these floors appears to have been rather unusual in character, for they are described as "paved with blocks of oolite, limestone, and sandstone—the latter mostly burnt quite dark in colour—and sea pebbles; in some parts flat slabs of limestone being paved edgewise." Abundance of broken Roman pottery of all kinds, from the valuable Samian ware to that of the rudest description, has been found. Among the animal remains are those of the ox, deer, hog, dog, and different species of birds, with a nearly complete skull of the wild boar. We may mention, among other objects met with, several portions of querns, half of a very small horse's shoe, not grooved, other fragments of iron, too much broken or corroded to enable us to judge to what implements they had belonged; a much defaced silver coin, two small brass coins of Constantine, and several peculiarly rubbed sea-pebbles and other stones, some grooved. It is also worthy of remark that among these Roman remains of a rather late date, were found some of the implements of stone which it is now the fashion to ascribe to a "stone age," such as "a remarkably fine red flint 'scraper,' a flint 'drill,' and some other flints, with a 'spindle whorl' of Samian pottery, and another similarly formed (unpierced) of stone." It appears that the nature of the ground is not favourable to excavations during the winter; but we are informed that the gentleman under whose direction they have been carried on, the Rev. James Robertson of Appleton, intends to resume them on the return of favourable weather.

T. W.

PROGRESS OF INVENTION.

Manufacture of Alcohol.—To prevent the formation of acids in the distillation of alcohol, and to neutralize any which may have been previously formed in the wash to be distilled, Mr. J. Fletcher Collins, of New York, has patented a process, in which he employs phosphate of lime to effect this object; and, still further with a view to prevent the formation of acetic acid, he conducts the distillation at a temperature not exceeding 176° F. At this low temperature, the vapours would not pass over freely; he therefore causes a current of air, or some suitable non-deleterious gas, to drive them from the still, instead of depending on excess of heat for their expulsion. In order to get sufficient pressure, the air or gas is introduced into the still through a pipe passing perpendicularly into it, and this pipe is carried to any convenient height, greater than a column of water at the normal pressure of the atmosphere. It is then bent downwards, and extended to the condenser in that direction, and by a similar pipe between the condenser and the still, the current is completed. This extension of the perpendicular pipe causes any aqueous vapour which might be formed to be retained.

Fireproof Floors and Ceilings.—It seems strange that more attention has not been given to rendering houses less liable to be destroyed by fire than they are at present. The employment of bad conductors of heat for the protection of the more inflammable materials which must of necessity be used, will, in a great measure, effect this object. If the floors and ceilings can be rendered comparatively fire-proof, there will be little danger of a fire, accidentally kindled, extending beyond the room in which it originated. A very simple and useful invention has been patented by Mr. John Thompson, of Carlisle, in which he proposes to place between the wood floor-joists a layer of cement, made of plaster of Paris or some other suitable non-conducting material, so laid as to form a smooth surface above the joists on which the flooring boards may be placed, or which will itself answer as a floor. To form a good bed for the cement, the joists are cut thinner at the top than below; this arrangement also has the effect of lightening the structure, which object may be still further attained by leaving hollows in the cement, between its upper and lower surfaces. These hollows are formed by earthenware tubes, or by others made of the cement itself. In this way all the constructive timber can be protected from fire, even should the flooring-boards, when they are used, be entirely consumed.

Indicating Taps.—It certainly is very desirable to be able to measure the quantity of beer or other liquid which has to be drawn in small quantities from a cask. An ingenious method of doing this has been invented by Mr. John Wood Ridley and Mr. John Withers. They make their tap so that it contains a hollow cylindrical chamber, in which another works which fits the first very accurately. The outer cylinder

or casing has two holes made in it of corresponding size, the one made in the upper part is the inlet passage, that below is for the passage out of the liquid. The inner cylinder is provided with one or more holes, which can be made to correspond with those in the outer casing, and can be turned round so as to allow one of its apertures being brought opposite to the inlet passage of the outside cylinder. The liquid is then free to flow from the cask and fill the inner cylindrical chamber; this is then turned round until its aperture corresponds with the outlet passage in the outer casing, the liquid then of course flows out. The inner cylinder is made to contain a known quantity, and, by a simple contrivance, can be made to register on an index the number of times it has been filled and emptied. The registering dials are arranged outside the tap, the pointers indicating somewhat after the manner of those used in gas meters.

CONVERSION OF CAST INTO WROUGHT IRON.—To burn out the carbon from cast iron by a cheap process, is a subject which has long engaged the attention of practical and scientific men. One which has lately been patented by Mr. John Heaton deserves consideration; the only question seems to be whether it is sufficiently economical to ensure its adoption. The principle on which it is founded, and the method of its application, seem excellent. The conversion of the carbon by nitrate of soda or chlorate of soda is the method he adopts; he also claims salts of potash as well as of soda. The application of these oxidizing agents is to be to the under surface of the molten iron, so that the oxygen may act from below upwards through its mass. The nitrate or chlorate is to be placed in chambers within the receiver of the melted iron, which is made to revolve, so that the chambers may come under the molten metal, and the nitrate or chlorate may act through it. The surface of the nitrate or chlorate is protected from a too rapid action of melted iron by means of an iron plate perforated with numerous holes. Mr. Heaton says, that if the cast iron contains about five per cent. of carbon, one hundredweight and a quarter of nitrate or chlorate will be sufficient for each ton of iron, and that the effect will be produced in three minutes. The same process may also be used for the conversion of cast iron into steel.

PEG FASTENINGS FOR BOOTS AND SHOES.—This invention of Mr. Briggs Smith, of Boston, U.S., seems to have so many other applications than simply to the manufacture of boots and shoes, that it seems worthy of notice. To avoid the expense of cutting a screw Mr. Smith uses a polygonal wire, which is twisted by a machine of his invention, before patented. This twisted wire is cut into suitable lengths for pegs, or for any other purpose to which it is to be applied. They can be driven in with a hammer in the usual way when once started in a hole prepared for them. The peg on being driven turns and holds very firmly.

A PORTABLE LAMP.—There are often occasions when a portable lamp

would be found very useful; one, which immediately occurs to the mind, is when in railway carriages the lamps provided by the company are not in good order, a circumstance which not unfrequently happens; such a lamp would then enable the traveller to occupy the weary hours with his book or newspaper. An American has invented a portable lamp of very simple construction; it consists merely of a long tube, or wick holder, provided at its upper end with a nozzle through which the wick protrudes, it has a shoulder on which a screw is tapped, which is screwed into the open end of the tube of a walking-stick, which forms the oil chamber. When the lamp is not in use the nozzle and wick are covered by the handle, or top of the stick, which is screwed on to the hollow part, and can be made to hold matches. The same apparatus can be arranged with a helical spring, so as to burn candles like an ordinary Palmer's lamp; a portable glass shade can be screwed on to the top of the walking-stick.

VINEGAR MANUFACTURE.—There is a very general complaint that the oxidation of spirits of wine in the vinegar process is far from complete, and that the results are not equal either in quality or quantity to what ought to be expected from the materials employed. Dr. Artus has made investigations in order to make the process more perfect, and he says that the success of a method which he discovered was perfectly satisfactory; that the oxidation was rapid and complete, and that the vinegar produced was of good quality and possessed an agreeable smell. He took half an ounce of dry bichloride of platinum, and dissolved it in five pounds of alcohol; with this liquid he moistened three pounds of wood charcoal broken in pieces to the size of a hazel-nut; these he heated in a covered crucible, and afterwards put them in the bottom of a vinegar vat. Here the platinum in its finely divided spongy state absorbs and condenses large quantities of oxygen from the air by which the alcohol is rapidly oxidized. When the charcoal has been in use for five weeks it should be again heated in a covered crucible.

PROCEEDINGS OF LEARNED SOCIETIES.*

ROYAL ASTRONOMICAL SOCIETY.—*January* 10.

A FEW papers were read on the meteoric shower last November, and one containing an observation of Jupiter as seen without satellites exterior to his disc.

Mr. De La Rue announced that some of the results of the photo-

* Interesting matter that comes before the Royal Society will usually be found cited from their "Proceedings" in "Notes and Memoranda."

graphic observations of solar spots at Kew would shortly be published. Those observations were now carried on simultaneously with Schwabe's at Dessau, and with equal continuity; and although from a better climate Schwabe more frequently saw spots, no important spot or group of spots was lost at Kew.

An announcement was made concerning Major Tennant's intended observation of the total solar eclipse in India next August. This gave occasion to Mr. Brayley to express a desire that the spectroscopical examination might include the most exterior atmosphere of the sun, perhaps beyond and containing the red flames, to see whether a discontinuous or gaseous spectrum could be traced in it. Mr. Joynson sent some further observations of Linné, and Mr. Buckingham orally communicated his own, purporting that he had seen changes in the position of the little crater in the white patch. Mr. Howlett compared this to what a lunarian might see on a smaller scale in Vesuvius.

Mr. Park Harrison read a paper on the amount of lunar radiation of heat at different parts of the lunation.

Mr. Stone announced a paper containing a new determination of the Moon's mass.

Mr. Browning described a new and very ingenious apparatus for observing the spectra of meteors.

ROYAL MICROSCOPICAL SOCIETY.—*January* 9.

J. Glaisher, Esq., President, in the Chair.

Professor T. Rupert Jones gave a very interesting account of the Entomostraca, and pointed out their abundance in geological formations of various periods. This paper was illustrated by an extensive collection of drawings and specimens.

LITERARY NOTICES.

THE FIRST PRINCIPLES OF MODERN CHEMISTRY. A Manual of Inorganic Chemistry for Students, and for use in Schools and Senior Classes. By N. J. Kay-Shuttleworth. (Churchill.)—THE FIRST STEP IN CHEMISTRY. A New Method of Teaching the Elements of the Science. By Robert Galloway, F.C.S., Professor of Applied Chemistry, Royal College of Science for Ireland, author of the "Second Step in Chemistry, a Manual of Qualitative Analogies," etc. Fourth edition, rewritten and enlarged, with illustrations on Wood. (Churchill.)—These two books are indications of the conflict of the old spirit of chemistry with the new. Mr. Kay-Shuttleworth, who has had the advantage of Dr. Frankland's assistance in revising his manuscripts and proofs, makes a very valuable attempt

to show how chemistry can be taught, so as to be a mental discipline as well as a valuable collection of facts, in strict conformity with Gerhardt's notation and the philosophy on which it is based. Professor Galloway re-edits an old work, which he wrote under the influence of ideas now abandoned by the best chemists, and which he enlarges by the addition of some matter compiled in conformity with the new system. He points out in his preface the importance of teaching chemistry so as to make it an instrument for developing the intellectual faculties, and then proceeds according to a plan which does not seem to us calculated to have any such effect. In this respect we should give a very decided preference to Mr. Kay-Shuttleworth's book, the plan of which is far superior to that of Mr. Galloway.

Our first objection to Mr. Galloway is his want of precision and accuracy of statement. In his first page he tells us "heat, light, and electricity cannot be exhibited in a mass, like wood, metal, water, air, etc.; they can be collected only through the intervention of other substances. They are likewise destitute of weight; hence they are called immaterial or imponderable bodies. They are considered to be produced by the vibrations of unknown and highly-elastic fluids, called ethers, which are supposed to fill the whole universe, and penetrate the pores of all solid and fluid bodies." Now, it would be difficult to compound a paragraph containing more unfounded assertions, suggesting more erroneous ideas, or less coherent with itself. First, we are told that heat, etc., cannot be exhibited in a mass, like wood, etc., and can only be collected through the intervention of other substances. What is the use of the commencing negation, and what can any one make of the affirmation? It is impossible to assign any definite idea to the phraseology, but it seems to indicate that heat and light are *substances*. Then we are told they are destitute of weight, and are called "immaterial bodies;" after which we are informed "that they are considered to be produced by the vibrations of unknown and highly-elastic fluids." We heartily pity the student who has to form a conception of an "immaterial body," capable of being collected by the "intervention of a substance," and "supposed to be produced by the vibration of an unknown fluid!" The following paragraph makes the confusion more confounded by further descriptions of heat, light, etc., as *bodies* differing from all other known bodies in not having weight and occupying a certain space. Thus the poor student employed to "collect" light, etc., has to collect a body that does not occupy a "certain space;" that is, which occupies no space at all, for if it occupied any space it would be a certain one. How an immaterial body which occupies no space can be *produced* by vibrations of an unknown fluid, Mr. Galloway does not try to explain. Mr. Brooke has shown that there is no necessity for imagining an ether penetrating all bodies, in order to explain light, heat, etc.; and all the confusion into which Mr. Galloway has fallen would have vanished, if he had been content to adopt modern ideas, and repre-

sent heat, light, etc., as being most probably merely modes of motion affecting matter.

When we turn to Mr. Kay-Shuttleworth's work we find this branch of the subject treated with much greater simplicity and logical accuracy.

Mr. Galloway discourses of the laws of combination somewhat late in his system, and with a studious preservation of all the old notions which more accurate thinkers have dismissed. We are told, for example, that "affinity causes unlike substances to unite together," and then we have disquisitions on "single elective affinity," "double elective affinity," and so forth, quite in the old style. Nothing can be less desirable than to return to our old metaphysical acquaintance "affinity," with its sham explanations of chemical action. Scientific teaching intended as mental discipline should use no words without definite meaning, and if the cause of an action is unknown, it should make a frank confession of ignorance. Affinity is relationship by marriage, and supposes some sort of resemblance in the objects concerning which it is predicated; and what is the good of saying that relationship of such a nature is a *cause* why two substances unite together. The kind of relationship which *causes* union is moreover said to be *unlikeness*—the most opposite substances being the most ready to combine. Mr. Galloway has had plenty of predecessors in these "affinity" explanations, but repeating old shams is not the best way to teach truth.

Mr. Kay-Shuttleworth explains these actions much better, but he might advantageously modify his statement that "absolute contact" is essential to chemical action—close proximity of atoms is all that we are entitled to assume.

In speaking of the so-called "elementary bodies," Mr. Kay-Shuttleworth very properly explains that he follows Dalton in regarding a substance as elementary until it is decomposed; Mr. Galloway incautiously states that "all substances which do not admit of being separated into simpler forms of matter, because they consist of one material only, are called simple substances or *elements*." He thus confuses together two distinct things, a negative fact, that a substance has not been decomposed, and a positive property, that of elementary composition. What substances are really elementary is not known.

In page 54 Mr. Galloway very properly states, that the "essential nature" of matter is unknown, but a little further on the pupil is asked to "enumerate the essential properties of matter, and the non-essential properties of matter," which in the absence of the knowledge declared not to exist, is impossible. Mr. Galloway probably means to ask for an enumeration of the properties belonging to all matter, and of those which belong to matter in particular conditions, or of particular sorts.

Some of the assertions scattered through the work will stagger many readers—such as the statement that yeast in producing fermentation acts simply by its own decomposition, causing the sugar to do the same, and

that hydrophobia is produced by introducing "putrefying matter" into the system. Part II. comes as a sort of appendix, giving the new views and nomenclature, which the student is expected to learn *after* he has learnt the other arrangements and statements. Now if the new views are more likely than the old ones to be correct, which may be assumed with considerable safety, why not teach them from the beginning, as Mr. Kay-Shuttleworth does in his valuable little work, which deserves great praise, and ought to be completed by extending it to the metals. The student who goes carefully through Mr. Kay-Shuttleworth's small volume will have gained an excellent insight into chemical philosophy as well as have acquired a very useful body of facts. Wherever we find occasion to complain of Mr. Galloway, Mr. Kay-Shuttleworth has merited praise in the corresponding part of his treatise, and though he has confined himself within much narrower limits, he has performed his task with much greater skill.

It should, however, be stated, in justice to Mr. Galloway, that his treatise contains a considerable mass of chemical information, not tainted by the bad philosophy of which we complain.

NOTES AND MEMORANDA.

THE ROTATION-PERIOD OF MARS.—Mr. Proctor gives the elements of his new determination of rotation-period of the planet Mars. A comparison of pictures taken by Mr. Browning in February, 1867, and published in THE INTELLECTUAL OBSERVER for September, with Hooke's observations in March, 1666—giving a period of nearly 201 years—have enabled Mr. Proctor slightly to correct his former estimate, in obtaining which one or two small errors had crept in. He now gives for Mars' sidereal day the period 24h. 37m. 23·73s., in place of the period 24h. 37m. 27·745s. first obtained.

STAR COLOURS AFFECTED BY APERTURE.—In THE INTELLECTUAL OBSERVER for October an account was given of the Lunar eclipse of September 13, and it was remarked that while Mr. Browning described an absence of the usual colours, they were seen by Mr. Slack, who was situated not far from Mr. Browning at the time. The discrepancy was referred to difference of aperture, Mr. Browning having employed a 10¼ silvered mirror, and Mr. Slack one rather less than 6½. Mr. Huggins communicated some important observations on the effect of excess of light in diminishing the visibility of colour. Mr. Browning has since stated (see "Monthly Notices" for December) that "a small star in the cluster in Perseus appears of an indigo blue with 8½ inches, Prussian blue with 10¼ inches, and royal blue with 12¼ inches of aperture." Thus it becomes necessary to state the aperture as well as the colour observed.

THE NEWTON FORGERIES: Fresh Evidence.—Amongst the collection of forgeries in which M. Chasles has unwisely placed such implicit faith, are letters pretending to be written by several of Newton's contemporaries, Huygens amongst the number. M. Harting, of Utrecht, points out ("Comptes Rendus") that the manufacturer of these epistles makes Huygens give an account of his discovery of the ring and satellite of Saturn, and of the rotation-period of the planet, which does not coincide with what he states in his works. M. Martin adduces from letters purporting to be written by Montesquieu specimens of bad French, apparently written by an Englishman, and he thinks

Desmaiseau, to whom Sir D. Brewster ascribes the forgeries, must have had an English assistant. Father Secchi also contributes a letter on this subject, which will be found in "Comptes Rendus," in which he shows that statements made about Galileo and his discoveries are incorrect, representing that philosopher as writing certain things with his own hand at a time when he was incapacitated by blindness. Moreover the matter he is alleged to have written is not consistent with facts. Father Secchi, "as an Italian astronomer, protests against these impostures." Nothing seems to convince M. Chasles, he harps upon the *quantity* of letters in his possession, and makes ineffectual efforts to deal with the overwhelming evidence against him. Probably no scientific man of eminence has ever shown such an unaccountable incapacity to appreciate proof in common affairs.

Excision of the Spleen.—M. Pean describes in "Comptes Rendus" a case in which he removed a diseased spleen from a young woman twenty years of age, who rapidly recovered.

Synthetic Chemistry: formation of Nevrine.—M. Liebreich obtained a crystallizable substance from the brain, which he called *protagon*, which proved to be a compound of phospho-glyceric acid, and a base called *nevrine*, containing, amongst its constituents, phosphorus and nitrogen. M. Baeyer showed that nevrine represented a hydrate of oxethyl-ammonium, in which three atoms of hydrogen were replaced by these methylic groups. M. Wurtz describes in "Comptes Rendus" a method of forming nevrine artificially. For the general reader we may observe that the interest in such questions is not confined to chemists. Every discovery of a process by which complicated compounds resembling, or identical with, those formed in living bodies, can be produced by purely chemical means, throws light upon physiological problems, and refers to the laws of known science actions often vaguely ascribed to "vital force."

New Treatment of Wounds.—M. Guerin has given the French Academy a long account of his method of treating wounds made by surgical operations, or otherwise, by what he calls "pneumatic occlusion" and "aspiration." The first consists in the application of an air-tight cover, and the last in drawing off vapours, etc., that are formed. He reports great success in avoiding fever, etc., and obtaining rapid cures.

Accuracy in Astronomical Observation.—The precision attained by astronomers is truly wonderful. For example, a comparison of the right ascensions of a long list of fundamental stars, as determined at Greenwich and at Paris, shows that the average difference of the two sets of observations is less than a hundredth of one second, being 0s. 007.

Improvements in Electrical Apparatus.—Mr. Browning has devised an improvement in the contact breaker of coil machines which considerably augments their power. It consists in an arrangement by which the hammer is retained much nearer to the soft iron core than when the ordinary break is employed, while the tendency of the contact points to burn is lessened. The details are very simple, but not susceptible of explanation without diagrams. The result is an increase in the length of spark obtained from the coil. The magnetization of the core seems more complete. Mr. Browning has also made a new magneto-electric machine for medical purposes, which is very elegant and efficient. His magnet is bent in a circular curve, and he is thus able to use *one* bobbin instead of two. Thus his currents are always in *one direction*, an important thing in medical use.

ROMAN LADIES AT THEIR TOILETTE.

THE STUDENT,

AND

INTELLECTUAL OBSERVER.

MARCH, 1868.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

(*With a Coloured Plate.*)

CHAPTER I.—(*Continued.*)

WOMAN IN GAUL AND BRITAIN UNDER THE CELT AND ROMAN.

We give in our coloured engraving, a copy of the Pompeian toilette-scene alluded to in the preceding paper. As we find not unfrequently in these wall-paintings, the drawing is not always correct. The lady to the right, who forms the most prominent figure in the picture, is seated in a somewhat anomalous manner, upon some seat which is not clearly visible, but it was probably intended for one of those chairs which are not unfrequently found in the Roman sculptures and pictures, one side of which only is imperfectly apparent between the lady and her *coiffeuse.* The second lady, too, is rather awkwardly seated. But that which is still more worthy of remark is the uniformity in the colour of the hair—all, ladies and servants, have hair of the same shade of yellow. Yellow hair, we know, was the favourite colour among the Romans. Pyrrha, the admired of Horace, was yellow-haired—

> "Cui flavam religas comam,
> Simplex munditiis?"
> Horat., "Carm., i. 6.

The verb *religas* is explained in the gloss by *nodo colligis, i.e.*, bind up in a knot, which is just what the maid is doing in our picture, and which was the usual *coiffure* of the Roman ladies. Catullus ("Carm." lxvi., line 62) speaks of the *flavus vertex*, or yellow crown, of his Berenice. Propertius, among the beauties of his Cynthia, says that her hair was yellow and her hands long—

> "Fulva coma est, longæque manus."
> Propert., "Eleg.," lib. ii. 2.

And Tibullus, when protesting against the supposition that his affections had been gained by magical incantations, says that his mistress fascinated him, not by the operation of such charms, but by the beauty of her face, the elegance of her limbs, and by her yellow hair—

> "Non facit hoc verbis; facie tenerisque lacertis
> Devovet et flavis nostra puella comis."
> Tibull., "Eleg.," i. 5, line 43.

So in Virgil, the hair of Dido was yellow; *flaventesque abscissa comas* ("Æn.," iv. 590), and

> "Nondum illi flavum Proserpina vertice crinem
> Abstulerat."
> "Æn.," iv. 698.

As well as that of Lavinia—

> "Filia prima manu flavos Lavinia crines
> Et roseas laniata genas."
> "Æn.," xii. 605.

Of course to produce this uniformity of colour, as seen in the Pompeian painting, artificial means must have been employed, either dye or powder, and we know that among the wealthy and extravagant it was not unusual to powder the hair with gold-dust. We shall not proceed far in the history of Womankind before we meet again with this practice of artificially colouring the hair.

We know very little of the dress of our Celtic forefathers, whether Gauls or Britons. If we believe some of the ancient writers, the British costume, as well as that of the Gauls—we cannot correctly call it dress—was simply nakedness painted blue, and by way of further ornament they had recourse to the practice of tattooing. Cæsar is the first writer from whom we derive this information, and he adds that the substance with which they painted, or rather dyed, their bodies, was derived from the plant woad. It is

repeated by other Roman writers, and was so generally believed, that when the poet Martial speaks of a lady of British descent, he talks of her ancestors as "azure-coloured Britons":—

"Claudia cæruleis cum sit Rufina Britannis
Edita, quam Latiæ pectora plebis habet!"
Martial, "Ep.," lib. xi. ep. 53.

This story has been so generally credited, that that worthy old historian, John Speed, in his folio "History of Britaine," has treated us with a carefully-executed picture of a British lady, in all her nudity, covered with tattooing of the most pictorial character. Yet I would venture to doubt if this were ever more than a fable.

Others of these hearsay stories of the manners and condition of people in distant countries have been handed down to us by the ancient writers, most of them probably no more worthy of credit than the one just told. Cæsar informs us that among the Britons in the interior of the island, by whom we are to understand the original Celtic population, the sentiment of domesticity was so imperfect, that ten or twelve men, generally belonging to the same family, had their wives in common, the children being considered as belonging severally to the man who first married their mother. The well-known stories of two British queens, Boadicea of the Iceni, and Cartismandua of the Brigantes, seem hardly consistent with a state of society such as indicated by these tales, either in the maritime states or in the interior of the island. However, at the time of Cæsar's invasion, social life among the Gauls was in a very low state of development, and had still hardly emerged from its patriarchal condition. He tells us that the husbands had the power of life and death over their wives and children, and it seems to have been generally assumed that the wife had no great love for her lord. When a man of importance happened to die suddenly, or in an extraordinary manner, it was taken for granted that his wife or wives were the cause of his death, and she or they were immediately seized and subjected to torture. If there appeared the slightest ground for suspicion, the unfortunate victims were committed to still greater torments, and finally burnt to death. An anecdote of Gaulish life is preserved in an epigram in the Greek "Anthology,"* which would seem to show that, at least in some parts of Gaul, it was taken as a general principle that a woman's fidelity to her husband was always to be suspected. Among the

* "Anthologia," lib. i. c. 43, ep. 1.

Belgic tribes the deity of the Rhine (for in those times every river had its god), was believed to pay especial attention to the conduct of the Belgian wives. In this belief the father took his new born child to the river, placed it upon his spacious buckler of wood, and launched it on the water. If it swam on the surface, the father was satisfied of the legitimacy of his paternity; if it sank, he was equally convinced of the illegitimacy of the child, abandoned it to its fate, and no doubt wreaked his vengeance upon the mother. Cæsar informs us of a custom which prevailed in Gaul in his time, the earlier half of the first century before Christ, which shows a marked advance towards the equality of the sexes. On a man's marriage, whatever sum he received with his wife under the name of dower, he added to it the same sum from his own property, and the whole was kept along with the fruits (*fructus*) as a reserved fund, which belonged to the survivor of the two. The mother, also, had the entire care of the children, until the boys had reached the age at which it was customary to instruct them in the use of arms, and, till that period a father looked upon it as disgraceful to appear publicly in company with his son.

No circumstance in ancient history is more remarkable than the readiness with which the peoples who came under the influence of Rome abanonded their nationality, and became Romans. Roman laws, Roman manners, and, more observable than all, Roman costume, gradually superseded those of the conquered. The two remarkable characteristics of the male costume of the Gauls were the wearing of trousers, or breeches, on the legs, and the practice of carrying their hair long. The first portion of Gaul which was formed into a Roman province was that within the Alps, and therefore nearest to Rome, which, on that account, was usually spoken of as Gallia Cisalpina; but from its early adoption of the Roman dress, it soon received the name of Gallia Togata, or Gaul where the toga was worn. When a second province was established, consisting of the portion of Gaul on the other side of the Alps, and bordering upon the Mediterranean, the inhabitants kept for some time their native costume, and on that account it was called Gallia Braccata, or Gaul where trousers were worn. The Gauls themselves knew this article of dress by a name Latinized into *braccæ*, or *bracæ*; it is remarkable that the same word, with the same meaning, is found also in the Teutonic languages—in Anglo-Saxon it is *bréc*, or *bræc*, the origin, of course, of our English word breeches. As the province became more Roman, the braccæ were abandoned, and the province received the new name of Gallia Narbonensis, from its chief town

Narbona (*Narbonne*). In the same manner, the next Roman province received the title of Gallia Comata, or hairy Gaul, so long as its inhabitants retained their old fashion of wearing their hair long.

It would appear that the trousers were a garment worn equally by the Gauls and the Teutons, and the name was probably one of the words common to both languages from their earliest formation. The Teutons, when they become known to us, also wore their hair long, and probably the costume varied little in the two races. But we are very imperfectly acquainted with that of the men, and we have still less knowledge of that of the female sex. The men, we are told, were very fond of dress, and prided themselves in a great display of personal ornaments, such as collars, bracelets, and rings. They dyed their hair of a bright red colour with a sort of pomatum, which Pliny says was made of tallow and cinders.* How far the Gaulish women imitated their husbands in these fashions we are not informed, but they probably adopted the red hair, and covered themselves with jewels, as far as lay in their power. We find, however, that in the state of society which the Romans included under the title of barbarism, the men are generally more given to display in dress and personal ornaments even than the other sex.

After the establishment of the Roman power in Gaul and Britain, the costume of the Romans in Italy was everywhere adopted. The Romano-Gaulish, as well as the Romano-British, lady, wore the tunic, the stola, and the palla, just as the Roman ladies of Pompeii wore them; and the personal ornaments of females found so plentifully in excavations on Roman sites in Britain and Gaul are all entirely Roman. But our materials for the history of Womankind during this period are very scanty, and are hardly to be looked for among the ancient writers. Yet we have a few interesting materials of another class, which are undoubtedly truthful, and which enable us to contemplate the features and costume of the inhabitants of Gaul and Britain in the earlier part of the Roman period. These are the sculptured monumental stones, which were no doubt intended by the sculptor to present portraits of the individuals he commemorated. Unfortunately, but a small number of them are preserved; and for this reason, and on account of their extreme interest, it seems desirable to give them all. Their importance is increased by the circumstance that, in most of them, the inscription enables us to give the names of the persons delineated, and tell who they were. I may add that the greater part of them have been published by our distinguished

* "Galliarum hoc inventum rutilandis capillis fit ex sebo et cinere." Plin. "Hist. Nat." lib. xxviii. c. 12.

antiquary, my friend Mr. Roach Smith, in his most valuable publication the "Collectanea Antiqua."

The first of these monuments, which was found at Mayence, represents a family of citizens of the Roman city of Moguntiacum.

A FAMILY OF MOGUNTIACUM (*Mayence*).

The head of the family, as we learn by the inscription on the stone, was Blussus, the son of Atusirus, and his profession was that of a navigator (*nauta*)—he was probably concerned in the commerce of the Rhine. His wife, the lady we see, was Menimane, the daughter of Brigio, and behind them stands their son Primus, who raised the monument to their memory, as a token of filial piety. Blussus died at the advanced age of seventy-five, but the lady appears to have been much younger, and probably outlived him many years, for the blank left in the inscription for the insertion of her age when she died has never been filled up. She was evidently a lady possessed of personal attractions, and was fully aware of it, if we may judge by the richness of her dress and personal ornaments. She wears first the tunic, which differs from the ordinary Roman tunic in fitting closely to the arms and bust, and in being furnished with long sleeves, which turn back in cuffs, resembling the modern gauntlet cuffs. It is gathered at the neck to a sort of frill, which is inclosed by a torques. The tunic reaches to the feet.

Over it Menimane wears the stola, which reaches only a little below the knees, and hangs loosely and gracefully over the breast. As Mr. Roach Smith observes, her jewelry is of no common description, nor niggardly bestowed. Upon her breast, below the torques, is a large rose-shaped ornament or brooch, and beneath it a couple of fibulæ; two more, of a similar pattern, fasten the stola near the right shoulder, and upon the left arm just above the elbow; an armlet encircles the right arm, and bracelets the wrists; and two of the fingers of the left hand have rings. Her hair is raised up into what was probably the fashionable *coiffure* of the day. This profusion of jewelry, and the money-bag which Blussus holds in his hand, bespeak a family of no inconsiderable wealth. The boy behind holds what is probably intended for a ball; and the mother, in spite of her brilliant attire, grasps in her hand the implements of weaving, to typify her attention to her household duties, and has on her lap her pet little dog. The couple sit in one chair, which casts a pleasing air of domesticity over the whole picture.

Our next cut represents a young maiden of the Roman town of Burdigala, the modern Bordeaux, where the monument was found. Her name has been lost by an accidental erasure of part of the inscription, and we only know the name of the father who raised this monument to her memory, which was Lætus. She also wears the tunic, and the outer garment (answering to the stola of the Romans), which here reaches lower than in the former instance. Her hair is dressed somewhat in the same style as that of the navigator's wife, and like her, also, she has her pet animals, in this instance, a kitten and a cock. There is a special interest attached to the former, as the domesticated cat is not mentioned in the ancient writers, and it has been recently asserted by one of our distinguished men of science that the cat was never domesticated by the Romans. The love of the Roman ladies, and sometimes the gentlemen also, for domesticated animals is well known. Every reader of the classic poets is acquainted with Lesbia's sparrow (*passer*) and Corinna's parrot. Martial has commemorated, in a graceful epigram, the qualities of Issa, the favourite little dog of the painter Publius.

> "Issa est blandior omnibus puellis;
> Issa est carior Indicis lapillis;
> Issa est deliciæ catella Publî."—Martial, "Epig.," i., 110.

And in another epigram he has furnished us with a list of the favourite pet animals of his time. The archæological discoveries at

Bordeaux have furnished us with another monumental figure of a young damsel of Burdigala, which is represented in the cut on the right. Her name is given in the inscription, as will be seen, as "*Axula, Cintugeni fi[guli] filia,*" Axula, the daughter of Cintugenus the potter. It is the first sepulchral monument with the name of a potter which has been discovered; and Cintugenus must have been a

A MAIDEN OF BORDEAUX (*Burdigala*).

THE POTTER'S DAUGHTER OF BURDIGALA.

man of wealth and distinction in his profession, for Mr. Roach Smith, to whom we owe the publication of this interesting monument, has not only traced the name of the family in other Roman monuments in the Museum at Bordeaux, but he has found it stamped as the name of the maker on Roman pottery found in London. Axula has rather a short dress, which exposes to view a well-defined pair of shoes; she holds in her left hand a basket of fruit, and in the right a mirror of the well-known Roman form, perhaps as one of the

first implements which the Romano-Gaulish damsel was taught to use.

The only other Romano-Gaulish female I have to show is a lady of Nemaustum—now represented by the town of Nîmes—which was engraved by the Comte de Caylus in the third volume of his "Recueil d'Antiquités." It is a head, sculptured in relief, and is interesting as giving an example belonging to the Roman period of the head-covering of the females. We will pass from it into our own island of Britain, where we are again indebted to the indefatigable labours of Mr. Roach Smith. Our next cut represents a piece of a broken monument belonging to the Roman town of Lindum, in Britain, which was dug up some years ago in the immediate

A LADY OF NÎMES (*Nemaustum*).

A LADY OF LINCOLN (*Lindum*).

neighbourhood of its modern representative, Lincoln, and is now preserved in the cloisters of the cathedral. It is, no doubt, intended for the portrait of a lady who lived in the ancient Roman town, and is interesting as an illustration of the costume of a British female of her age, which Mr. Roach Smith places under the reign of Severus, or very soon after—that is, in the earlier part of the third century of the Christian era. She wears, evidently, the tunic and the stola, the former terminating in what bears some resemblance, like that of Menimane, to a frill, the latter open in front; but the object of most interest is her necklace, which is evidently formed of jet beads, resembling those which are found not unfrequently on ancient sites, and especially on sepulchral interments in Britain. They are flat on one side, and ribbed on the other, and were no doubt of native manufacture.

DRESS OF A NORTHUMBRIAN MATRON UNDER THE ROMANS.

Our last cut is that of a statue found at Chesters, in Northumberland, the site of the Roman station of Cilurnum. The tunic, reaching to the feet, and the stola, descending only a little below the knees, are well and distinctly pictured, and may probably be considered as representing those articles of dress as worn by a lady of rank in the country to the north of the Humber. The character of the waist-band, or girdle is especially remarkable. The statue appears to have been intended for that of a goddess—supposed to be Cybele, who is worthily represented in the well-known garb of a matron. It is to be regretted, however, that our Romano-British matron has lost her head.

In these few sculptured monuments, we have seen something of the appearance of the ladies of Gaul and Britain during the time they remained Roman provinces. The same class of monuments furnishes us with some curious illustrations of the domestic sentiments as they prevailed—or, at all events, existed—during the same period. It was the practice of the Romans to make of their tombstones affectionate memorials to the departed on the part of

the survivor, and the inscriptions often contain traits of personal character which, if not always strictly true, tell us at least what were the qualities which the people of those days valued most in the female sex. It is thus among the abodes of the dead that we must seek for the last traces of the virtues of Womankind in Roman Gaul and Britain. We find these memorials of affectionate feelings at the very extremity of our British province. At Chesters, in Northumberland (*Cilurnum*), a station on the line of the Wall of Hadrian, an altar monument was found, dedicated by Fabius Honoratius and his wife, Aurelia Egliciane, to the memory of their "most sweet daughter" (*filiæ dulcissimæ*), who was named after her father, Fabia Honorata. They were a family of Vangiones—a people of Belgic Gaul. At Carvoran, another Roman site on the line of the Wall, a monument was inscribed by a centurion, named Aurelius Marcus, as a testimony of his affection for "his most holy wife, who lived thirty-three years without a single stain."

OBSEQVIO CON
IVGIS SANCTIS
SIMAE QVAE VI
XIT ANNIS XXXIII
SINE VLLA MACVLA.

The lady in this case was a native of Salona.*

If we go over to Gaul we shall find these affectionate memorials in greater numbers. Many of them have been collected by Orellius, in his valuable work on "Latin Inscriptions," and in the supplementary volume by Henzen. Some of the more common epithets applied by husbands to their wives in these early inscriptions are "most affectionate wife" (*uxor piissima*), "most dear spouse and wife" (*sponsa ac marita karissima*), "most innocent woman" (*innocentissima femina*), "incomparable woman" (*incomparabilis femina*). Many of these monuments have been found at Lyons, on the Rhone, the Lugdunum of the Romans. One of them was dedicated by Silenius Reginus to his most dear sister, Camilla Augustila, "who lived thirty years and five days, and for whom none of her kin ever grieved except at her death."† Two of these ladies of Lyons, most remarkable for their virtues, were Greeks by birth. One, Lanina Galatia, had lived, according to her husband's testimony, thirty years without any sin.‡ Arelatum, also, the modern Arles,

* These inscriptions are published by Dr. Bruce, in his great work on "The Roman Wall."

† "De qua nemo suorum unquam doluit nisi mortem." Orellius, vol. ii., No. 4464.

‡ "Quæ vixit annos xxx sine ulla animi læsione." Orellius, vol. ii., No. 4465.

appears to have furnished some good examples of Womankind. A young married woman named Julia Lucia, who died at the age of twenty years and eight months, is declared by her husband and father-in-law, who erected the monument, to have been, "in morals as well as in accomplishments an example for the rest of Womankind."* The wife of a citizen of Narbonne was "dutiful and thrifty." A lady of Avignon, or, at least of the neighbourhood, was "dutiful and chaste," and her husband, in his regard for her, dedicated to her "the best memorial his poverty would permit."†

The ladies, be it said to their credit, were not in arrear with their husbands in these testimonials of affectionate feeling. A townswoman of the Roman Lugdunum of the Batavi, now Leyden, named Nævia Fortunia, speaks of her deceased spouse as "an incomparable husband, with whom she had lived nineteen years."‡ A monument raised, on the other hand, by a husband to his wife but found in Italy instead of Gaul, gives us rather an interesting enumeration of what were considered to be the domestic virtues of an excellent woman. The literal translation of this memorial, which was inscribed on a sarcophagus, is, "Here has been laid Amymone, the daughter of Marcus, in character most excellent, in person most beautiful, a diligent plyer of the distaff, affectionate, modest, thrifty, chaste, *and a keeper at home.*"§

In all the long list of affectionate memorials from husbands to their wives, I have only met with one example of a contrary character, and I rejoice to say that it was not found within the limits of Britain or Gaul. It belongs to Rome itself. A Roman named Marcus Ulpius Cerdo, it tells us, "has erected this monument to his dearest wife, Claudia, daughter of Tychenus, with whom he lived two years, six months, three days, and ten hours. On the day of her death I gave the greatest thanks before gods and before men."|| The period of his married life must, indeed, have weighed heavy upon Marcus Ulpius Cerdo, when he reckoned it up so minutely.

* "Quæ moribus pariter et disciplina ceteris feminis exemplo fuit." Orellius, vol. ii., No. 4638.

† "Conjugi piæ et castæ . . . . maritus qualem paupertas potuit memoriam dedi." Orellius, vol. ii., p. 220, No. 4648.

‡ "Conjugi incomparabili cum quo vixit annos xix." Orellius, vol. i., No. 171.

§ "Hic sita est Amymone Marci, optima et pulcherrima, lanifica, pia, pudica, frugi, casta, domiseda." "Orellius," vol. ii., No. 4639.

|| "Cum qua vixit annis ii., mens vi., dieb. iii., hor. x. In die mortis gratias maximas egi aput deos et aput homines." Orellius, vol. ii., No. 4636.

THE HOUSE OF LORDS.

BY FRANCIS W. ROWSELL, BARRISTER-AT-LAW.

The House of Lords, as at present constituted, consists of the Archbishops of Canterbury and York, twenty-four English bishops, one Irish archbishop, three Irish bishops, all English barons who have attained twenty-one years of age, sixteen Scotch peers, and twenty-eight Irish peers; the two last classes being the elected representatives of the body of their fellows. These make up the total of spiritual and temporal lords of Parliament.

The Scotch and Irish peers were admitted in 1707 and 1801 respectively, the dates of the union of their countries with England; and before the 33 Henry VIII. c. 13, by which Act all monasteries and abbeys were suppressed, the roll of English spiritual peers (increased as regards the number of bishops since that time) was strengthened by the addition of twenty-seven mitred abbots and two priors. There are two English bishops, besides the above-mentioned twenty-four, but they have no seats in the House; one of these is the Bishop of Sodor and Man, the other is the junior bishop, unless he be of the diocese of London, Durham, or Winchester. These sees are always represented.

The temporal peers must be barons, though, in addition to this dignity, they may have any higher titles of nobility, as dukes, marquises, earls, viscounts. Baron is the minimum degree of qualification for a peer of Parliament. But peerage being a social rank, as well as a qualification for a seat in Parliament, its dignities are classed for purposes of precedence as follows:—viz., 1. peerages which in their creation were peerages of England; 2. peerages of the United Kingdom of Great Britain; 3. peerages of the United Kingdom of Great Britain and Ireland; 4. peerages of Scotland; 5. peerages of Ireland.

The House of Lords is at the same time a legislative assembly and the highest court of justice in the kingdom. That which answered to it under the Saxon Heptarchy was composed not only of the great chiefs with titles of nobility, but of the principal landowners and others interested in property, together with all the bishops and abbots, who sat in accordance with a custom which obtained amongst all the northern nations, and which secured for the state the advice and learning of the best informed men of the age. The Norman conquest made a change in the constitution

of the English Great Council. Under the peculiar circumstances with which the Normans found themselves surrounded, as conquerors in a country where the people were possessed by an undying hatred for them, it became necessary that the governing body should consist of men who were more or less dependent on the king, or rather who were bound together by interests which they had in common with him and with each other. So the Great Council of the kingdom to which William I. looked for advice was composed wholly of men who held baronies, or military fiefs, directly from the Crown, and they were called, in the language of the law, the king's tenants *in capite*. The ecclesiastics, who in the Saxon times had sat by virtue of their supposed superior wisdom, were not exempted under the Norman rule from the essential qualification of baronage. Granted that they sat by the same title as formerly, the necessity of their rendering military service for the baronies they held was superadded, and without a barony they could not sit at all.

But it is obvious that the attendance of all the tenants in chief of the king at the king's council must soon have been found inconvenient, if not to the king, at least to some of the tenants; and before the reign of Henry III. a custom appears to have prevailed, that, besides being a tenant of the king, it was necessary, in order to constitute him a lord of Parliament, a tenant should receive a special writ of summons. The greater barons had their particular writ from the king, and the lesser barons were summoned generally by proclamation of the sheriff. These lesser barons, either from indifference, from dislike of the expense of attending, or from whatever cause, soon got to disregard their summons to Parliament, so far as they individually were concerned; but, in order that their interests might not be unrepresented in the Council of the nation, they chose certain knights out of their body, who should go to Parliament, and speak there for them all; and these knights of the shire—afterwards developed into the county members of the House of Commons—represented in Parliament those tenants of the king to whom special writs of summons had not been sent.

For some time baronage by tenure, and then tenure coupled with a writ of summons, constituted the claim to be a lord of Parliament; but another mode of creating a peer came into vogue about the time of Richard II., who created Sir John Holt a peer by royal patent unconnected with tenure. Before that time, and down to the reign of Henry VII., it seems to have been the practice to summon to Parliament persons, who certainly were not peers by

tenure, by means of a writ addressed specially to them. Whether they were considered as on an equality with the other barons, which is most likely; whether, having once been summoned, they had a right always to be summoned; and whether they were not summoned in virtue of being heirs to, or having intermarried with the representatives of, some barony, are questions not conclusively settled; but it is certain that persons were summoned, and actually sat in the House of Lords, by virtue of writs which were not always renewed, and which undoubtedly were not of necessity issued to their descendants. These were called barons by writ.

There was another method of making peers, viz., by Act of Parliament; but Mr. Hallam qualifies this method by saying that the peerages created by it were only of the highest kind, as of duke or earl, and suggests that while the consent of the Lords and Commons is expressed to the new dignity, it was only by way of further assurance, and was not essential—the king being then as now the source and fountain of honour. Edward III. made several peers in this way; Richard II. granted the new title of "Marquis" of Dublin to his favourite Vere, with full consent of all the estates. Henry V. made his brothers Dukes of Bedford and Gloucester in the same way; and in the reign of Henry VI. Sir John Cornwall was made Lord Fanhope "by consent of the Lords, in the presence of the three estates of Parliament."

Peers were therefore Lords of Parliament by virtue of tenure, tenure and summons, writ, Act of Parliament, and patent. At one time they constituted the only legislative assembly in the kingdom, and they continued to be so even after the admission of the representatives of towns among their members; for it was not until an insecure dynasty came upon the throne, dependent in a great measure upon the good will of the people for support, that the consent of the Commons, whose functions had been hitherto only to vote the taxes which their towns should pay, was invited to agree to enactments of a purely legislative character. In the twenty-eighth year of his reign Edward I. ratified the statute of Winchester "at the request of his *prelates, earls, and barons,* assembled in his Parliament holden at Westminster;" and he assented to the 35 Ed. I., st. 1., "by the counsel of his earls, barons, great men, and other nobles of his kingdom." The first decided mention of the Commons as an assenting body is in the statute 7 Ed. II., "Ne quis occasionetur pro reditu Petri de Gaveston," and there is a statute of Edward II., quoted in the first report of the Lords on the dignity of a peer (1819), though not mentioned by Ruffhead, which declares the consent of *all* estates

to be necessary to legislation; but it was, nevertheless, not until quite the latter part of the reign of Edward III. that the concurrence of both Houses in legislation was made essential. Statutes of Edward III. are expressed to be passed "at the petition of the Commons, and by the assent of the Lords;" at the request of the Commons it is "enacted by the king and his Lords"; by the consent of "the prelates, earls, barons, and other great men of our realm;" "upon deliberation and treaty with the prelates and the nobles, and learned men assisting us." A statute passed in the first year of Richard II. is "by the whole consent of the prelates, etc., at the instance and especial request of the Commons of our realm." From Henry IV. to Henry VI., the enacting clause runs "by the advice and assent of the Lords spiritual and temporal, and at the special instance and request of the Commons of the realm, being in the same Parliament." It was not, therefore, until the House of Lancaster came to the throne that the concurrence of both Houses in legislation, a privilege fought for rather than enjoyed under Richard Plantagenet, was established as a constitutional point; and thenceforth the peculiar characteristic of the House of Lords as the sole legislative assembly was gone for ever. It continued, however, to be distinctive in its character of Grand Council of the king, and even so late as 1640, the year in which the last summons was issued to tenants by knight service to follow the king to a foreign war (the war of Charles I. against the Scots), the king rather than meet a regular Parliament convoked the Grand Council of the peers to meet him at York, there to advise him as to the course he should pursue. Such a Council was, of course, useless as a substitute for a Parliament, and the only advice it gave to Charles was that he should call a Parliament as soon as possible. Since that time no like attempt has been made to revive the dead function of the House of Lords, either solely to legislate or solely to advise. Some trace of the latter privilege is, perhaps, to be found in the theory of the constitution of the Privy Council, and in the right which every peer has at any time to approach his sovereign, and to offer such advice as may seem to him reasonable.

As a Court of Justice, however, it still enjoys all its ancient rights, though practice has limited its jurisdiction to the hearing of appeals, and deprived it, except for the purposes of impeachments and the trial of its own members, of its authority as a court of first instance. Originally, it was the only tribunal before which complaints could be brought, at the same time that it was the only body in the State which could make laws. About John's time, the

Committees of the House to which such complaints were commonly referred, were erected into the permanent Courts of King's Bench, Common Pleas, and Exchequer, the judges of which are to this day, in recognition of their judicial origin, called Lords Justices in the first two courts, and Barons in the Exchequer. More than this, they also receive, at the calling of every new Parliament, writs of summons to the House of Lords, where seats are specially set apart for them. The object, however, of summoning them is only that the House may have the benefit of their advice if needed; and whenever that is so, a special notice, without which they are not expected to attend, is sent to them. The writ of summons differs from that sent to other lords, in that the words *ad consentiendum*, are left out.

On the principle that the power which the House thus delegates is inherent and intact within itself, the House of Lords both entertains appeals from all the courts, which are its committees, and claims to have an original jurisdiction in all cases whatsoever. This latter claim, however, was vehemently opposed by the House of Commons in the case of Skinner, in Charles the Second's time; and seems moreover, to be counter to the fundamental principle of English law, that a man shall be tried by his peers. The claim is, moreover, objectionable because it does not admit of any appeal, since there cannot be an appeal from the decision of the highest court in the realm.

The case of Skinner was briefly this:—Thomas Skinner, a merchant, petitioned the king (Charles II.) to notice that he had gone as a merchant to the Indian seas, at a time when there was no restriction upon Indian trade; that the East India Company had taken away his ships, his property, and an island which he had bought of a native prince; and he prayed his Majesty to afford him redress. The Privy Council failed to settle the matter, so the King sent all the documents to the House of Lords, with a recommendation to do justice to the petitioner. The House overruled the exceptions taken to its jurisdiction, and awarded Skinner five thousand pounds damages. The East India Company petitioned the House of Commons, which referred the case to a committee; and the committee reported that the House of Lords, in taking cognizance of an original complaint, relievable in an ordinary court, had acted illegally, and in a manner to deprive the subject of the benefit of the law. In return for this the Lords voted, "That the House of Commons, entertaining the scandalous petition of the East India Company against the Lords' House of Parliament, and their pro-

ceedings, examinations, and votes thereupon had and made, are a breach of the privileges of the House of Peers, and contrary to the fair correspondency which ought to be between the two Houses of Parliament, and unexampled in former times; and that the House of Peers, taking cognizance of the case of Thomas Skinner, merchant, a person highly-oppressed and injured in East India by the governor and company of merchants trading thither, and overruling the plea of the said company, and adjudging five thousand pounds damages thereupon against the said governor and company, is agreeable to the laws of the land, and well warranted by the law and custom of Parliament, and justified by many Parliamentary precedents, ancient and modern."

Two conferences which took place in consequence of this declaration proved abortive, neither side consenting to withdraw from its assumed position. Skinner was ordered into custody by the House of Commons for a breach of privilege; and Sir Samuel Barnardiston, the chairman of the East India Company, and a member of the Lower House, was in return sent to prison by the House of Lords, and fined five hundred pounds. The king tried to stop the quarrel by prorogations and adjournments; but after these had continued fifteen months the heat had not cooled down, and, at the recommendation of the king, the record of all that had been passed on the subject was erased from the journals of the two houses. This was done, and there the matter dropped. "From this time," says Mr. Hallam, "the Lords have tacitly abandoned all pretensions to an original jurisdiction in civil suits."

In presentments of a criminal nature, however, their power in certain cases is as full as ever it was, viz., for the trial of any of their own members who may be accused of felony, and of such persons, whether peers or commoners, as may be impeached before them by the House of Commons. Jurisdiction in the former case is given by the fundamental rule of criminal procedure, recognized in Magna Charta, though older than it, which declares that every man shall be tried by his peers when put on his trial for felony. At one time the privilege of peerage in this respect extended to the trial of misdemeanours, but now a peer is liable to be tried before a jury for this class of offences.

The second case in which the House of Lords may be called upon to sit as a Court of Justice in criminal issues, or even on charges of misdemeanour, is the case of an impeachment by the House of Commons. An impeachment involves an accusation by the Commons of England, and the trial of the accused by the

Lords. It is beneath the dignity of the House of Commons to appear before any court but the highest. That House is not, never has been, a Court of Justice itself for any other purpose than that of administering the law of its own privileges; and, except in the extravagant case of Mr. Floyd in the reign of James I., in which its usurpation of power was at once and strenuously opposed, it never has pretended to judicial functions. But, as the representative of the Commons, it early arrogated the right to stand forth as the accuser of any one whose conduct had made him justly obnoxious to the nation at large; and this accusation, for the reason already given, was to be presented only to the House of Lords, who should also try the issue. The first case of parliamentary impeachment was in 1376, towards the end of Edward the Third's reign, when the Lords Latimer and Nevill, and four commoners, were accused by the House of Commons of having caused the staple to be removed from Calais, where the Parliament had fixed it; of having lent money to the king, at an exorbitant rate of interest; and of having bought up, at a low rate, certain old debts of the Crown, which they afterwards induced the king to pay them in full.

In the fourth year of Edward III., *the king* accused Sir Simon de Bereford to the Lords, of having participated in the treason of Roger Mortimer, and the House protested "that, albeit they had taken upon them, as judges of the Parliament, in the presence of the king, to render judgment, yet the peers who then were or should be in time to come were not bound to render judgment upon others than peers, nor had power to do so; and that the said judgment thus rendered should never be drawn to example or consequence in time to come, whereby the said peers of the land might be charged to judge others than their peers, contrary to the laws of the land." This protest, be it observed, was against charges instituted by the king, to whom the regular courts were open, so that he had no need to resort to this special tribunal. It is also to be remarked of the 29th chapter of Magna Charta, already alluded to, that the declaration as to trial before equals contained in it has reference only to suits instituted by the king. The case of so extraordinary an accuser as the whole people of England was not provided for, either by the common law or by statute, and it was only established by actual practice in the case quoted above, in several cases under Richard II., and in the case of the Duke of Suffolk under Henry VI.

Between Henry VI. and James I. no case of impeachment, properly so called, occurred; but in the latter king's reign Sir Giles

Mompesson, Michell, a Justice of the Peace, Sir J. Bennet, Judge of the Prerogative Court, the Bishop of Llandaff, Lord Bacon, and the Earl of Middlesex, were impeached and duly tried before the Lords. In the reign of Charles I., besides the Earl of Strafford and Archbishop Laud, several commoners were impeached, and not any objection was made by the Lords to try the cases; but in 1681, when Fitzharris was impeached of treason, the Lords voted that he should be pursued at common law. The House of Commons, in consequence, passed a resolution, "that it is the undoubted right of the Commons in Parliament assembled to impeach before the Lords in Parliament any peer or commoner for treason, or any other crime or misdemeanour: and that the refusal of the Lords to proceed in Parliament upon such impeachment is a denial of justice, and a violation of the constitution of Parliament." There is now no question but that the House of Lords has the right, which it is bound to exercise, of trying any one, peer or commoner, on charges presented by the House of Commons.

The privileges of peers are—1. That every lord, spiritual or temporal, summoned to Parliament, and passing through the king's forests, may, both in going and returning, kill one or two of the king's deer without warrant, in view of the forester if he be present, or on blowing a horn if he be absent, that he may not seem to take the king's venison by stealth. 2. That they may give their proxies to other peers, to vote as their representatives, a privilege not enjoyed by the members of the Lower House, because they are themselves but the representatives of others. 3. They may enter their protest, or written reason for dissent, against any Bill which passes contrary to their votes. 4. All Bills affecting the peerage must be originated in their House, and cannot be altered out of it. 5. Peers are free from arrest in civil suits in all cases, even when Parliament is not sitting, because they are supposed to be either advising the sovereign, as one of his Great Council, or defending his kingdom, as one of his military tenants. 6. They have the right of access, individually, at all times, to the sovereign—a privilege which the House of Commons enjoys only collectively. 7. On trials for high treason they have a right to be tried by all the peers entitled to sit and vote in Parliament.

Peers are not sworn, but give their evidence and their verdict "upon their honour." In case of giving verdicts, the youngest peer is first called upon for his vote.

In 1648 the Commons passed a resolution, that the House of Peers was useless and dangerous, and ought to be abolished. It

was abolished until the restoration of the monarchy, the Lords meantime retaining their titles both in public and private use, and some of them even consenting to sit in the Lower House as county members. In 1641 Charles I. consented to a Bill for ousting the bishops from Parliament, and they ceased to form any part of the Legislature till their restoration by the first Parliament of Charles II., held after the dissolution of the Convention Parliament.

Though strong arguments have been urged in favour of life peerages, and some sort of precedent might be found for them in the baronies by writ, already mentioned, the House of Lords have ever firmly resisted the claim of the Crown to grant them; and in the case of the present Lord Wensleydale, they declined to let his lordship sit until the peerage conferred on him for life was recalled, in favour of one made out with the usual limitations to heirs.

Lord Coke tells us that, at the time he was writing, the temporal peers numbered 106. The roll of peers at the beginning of the present Parliament showed 465 names, including 4 peers of the blood royal, 30 spiritual, and 431 temporal lords. The Bishop of Chester was the junior bishop (then without a seat in the House), and among the names last added to the roll of temporal peers were those of Lord Cairns and Lord Strathnairn (Sir Hugh Rose).

ON THE NEW THEORIES IN CHEMISTRY.

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No. I.

THE object of these articles is not to lay before the reader anything new with respect to modern chemical theories, neither do they profess to represent them in a more clear and philosophical manner than has been done by the eminent chemists Williamson, Wurtz, Nacquet, and Kekulé. In this respect they can bear no claim to a comparison with the works of these distinguished professors, to whose treatises those who desire to follow out the subject fully are referred. There is, however, a large class of scientific men whose labours in other directions prevent their keeping themselves *au courant* with the rapid advances made in chemical science, and who, years ago, laid the foundations of their chemical knowledge in a school whose teachings have almost entirely given place to other and newer theories. Such persons hesitate in entering on an investigation which seems like beginning their work afresh, and they dread giving up their hold on what they have always regarded as fixed and settled, to grapple with theories, which, even their advocates, cannot but admit are open to further change and modification. But men, whose pursuits are scientific, can hardly rest contented with the knowledge of any science as it stood twenty years ago; they cannot afford to wrap themselves up so completely in their own particular studies, as to ignore progress in one which affects more or less all branches of natural science, and underlies all their phenomenon. Anatomy, physiology, geology, botany, all are receiving help from chemistry, which is, in a manner, changing the method of their study, and opening out in them new fields for investigation, in which chemical knowledge of no mean degree of accuracy is required; and the chemistry to be employed is not the chemistry of the past, but of the present, not that in which facts were represented so as to support theories, but where theories, formed from careful observation of facts, are only maintained as long as they lead to their elucidation. There are also many students who have made themselves acquainted with the facts of elementary chemistry, but who have yet to learn the connection subsisting between them, and who are consequently unable

to appreciate the theories which have been formed concerning chemical combination, or to recognize their importance in facilitating the acquisition of sound chemical knowledge, according to a method which supplies a valuable training for the mind.

We shall find the best mode of approaching theoretical chemistry is through experimental fact.

If eighteen grammes* of water be decomposed by the galvanic current, hydrogen is given off at the negative, and oxygen at the positive pole of the battery; the weight of hydrogen will be two grammes, and that of the oxygen sixteen grammes. Thus hydrogen is seen to combine with oxygen in the proportion of two to sixteen, or of one to eight; the symbolic value of oxygen, therefore, hydrogen being taken as one, is eight. If thirty-nine grammes of potassium be made to act on water, and if the excess of water be evaporated and the residue heated, the product will be found to weigh fifty-six grammes, and to contain sixteen grammes of oxygen, one of hydrogen, and thirty-nine of potassium—

$$\underset{(18\text{ grms.})}{H_2O} + \underset{(39\text{ grms.})}{K} = \underset{(39\text{ grms.})}{K}\ \underset{(1\text{ grm.})}{H}\ \underset{(16\text{ grm.})}{O} + \underset{(1\text{ grm.})}{H.}$$

The same weight of hydrogen being set free as combines with the potassium and oxygen. If this substance be fused with potassium, one gramme of hydrogen will be driven off, and thirty-nine grammes of potassium will take its place, thus—

$$\underset{(39\text{ grms.})}{K}\ \underset{(1\text{ grm.})}{H}\ \underset{(16\text{ grms.})}{O} + \underset{(39\text{ grms.})}{K} = \underset{(94\text{ grms.})}{K_2O} + \underset{(1\text{ grm.})}{H.}$$

The resulting compound K_2O will weigh ninety-four grammes. In the first of these experiments thirty-nine grammes of potassium have been made to take the place of one gramme of hydrogen, in the second the other gramme of hydrogen has been replaced by thirty-nine grammes of potassium; thirty-nine grammes of potassium are therefore equivalent to one gramme of hydrogen or eight grammes of oxygen, making the assumption that combination and replacement are the same thing. Now if the latter compound of oxygen and potassium be treated with hydrochloric acid, and be heated to a temperature, insufficient to volatilize any of the salt formed, it will be found to weigh one hundred and forty-nine grammes, and, on analysis, to contain only potassium and chlorine,

* A gramme is equal to 15·432349 English grains.

there being twice thirty-five point five grammes of chlorine, and twice thirty-nine grammes of potassium, thus—

$$K_2O + 2\ (H\ Cl) = 2\ (K\ Cl) + H_2O.$$

The compound of potassium, hydrogen, and oxygen will give, with hydrochloric acid, a potassium salt, in which thirty-nine grammes of potassium are combined with thirty-five point five* of chlorine, one gramme of the hydrogen uniting with the hydrogen of the hydrochloric acid, and the oxygen of the potassium compound to form water, thus—

$$K\ H\ O + H\ Cl = K\ Cl + H_2O.$$

It appears, therefore, from these two last experiments, that thirty-five point five grammes of chlorine are equivalent to thirty-nine grammes of potassium, or to one of hydrogen; and that in the compound K_2O, obtained by replacing the two hydrogens of water by two potassiums, the oxygen has been replaced, in the first instance, by twice thirty-five point five grammes of chlorine, and in the second by thirty-five point five grammes of chlorine and one of hydrogen; and as thirty-five point five grammes of chlorine are equivalent to one gramme of hydrogen, two grammes of hydrogen can replace sixteen grammes of oxygen, and as sixteen grammes of oxygen are eight times as heavy as two grammes of hydrogen, they are sixteeen times as heavy as one gramme of hydrogen; and this proportion holds good whatever weights may be taken. In these illustrations definite weights have been supposed, because it is easier for many minds to grasp an idea presented to them in this form than when it is at first dealt with in the abstract. If we can conceive a particle of an element, so small that it admits of no further division, and which is capable of entering into combination with another such particle of the same element, or of any other element, we shall understand what is meant by the word atom, as used in the assumption of the atomic theory. That the atoms of different elements have not the same weight, is clear from the illustrations before given, in the action of potassium on water, in which it was shown that the hydrogen was displaced in two successive stages, and that the atom of oxygen weighs sixteen times as much as the atom of hydrogen. The example was given in grammes, and whatever were the relative weights of these two elements in this instance, that relation remains the same for any, even the most minute divisions of them. Hydrogen being the lightest body known is taken as

* 35·5.

the standard, and to it, as I, the atomic weights of all known elements are compared, and if these elements can only combine with hydrogen in the proportion of their atomic weights, it is clear that they can only combine with one another in the same proportion; that is, if the atom of oxygen, sixteen, is the smallest quantity of oxygen which can combine with the atom of hydrogen which equals one, and if the atom of carbon equalling twelve (the atomic weight of carbon) is the smallest quantity of carbon which can combine with hydrogen equalling one, carbon and oxygen combine in the proportion of twelve to sixteen.

Dalton devised the atomic theory to explain observed facts, and, whatever changes may take place with respect to it, whether it will continue to be held by chemists as it has hitherto been, as a satisfactory explanation of those facts, or whether there are grounds for the dissatisfaction expressed concerning it in certain quarters, is beyond the scope of these articles to discuss; one thing, however, is certain, that to it we owe a lasting debt of gratitude, for on it has been founded our present advanced knowledge, and the simplification of the laws relative to chemical combination. We have already seen that in water, one atom of oxygen, whatever be its weight, whether sixteen grammes or sixteen pounds, combines with two atoms of hydrogen, each weighing either one gramme or one pound. If two measures of hydrogen and two of oxygen be mixed, and then be caused to unite by an electric spark, only three measures of gas will remain, that is, supposing the water formed to be in the gaseous state, two volumes will consist of water vapour, and one of oxygen will remain uncombined, so that only two measures of hydrogen weighing two grammes, and one measure of oxygen weighing sixteen grammes, can, under these and similar circumstances, combine together. The condensation which takes place when some gases unite to form other compound gases, will be noticed afterwards. It may be well to remark here, to avoid misconception, that another compound of oxygen and hydrogen can be formed, in which two atoms of hydrogen unite with two of oxygen, but the combination is not effected directly, as appears from the fact that, where the two gases are mixed in these proportions and combination is effected by the electric spark or by heat, one atom of free oxygen is left. The body H_2O_2 can only be obtained by indirect methods, and the union of the second atom of oxygen is so weak, and the compound so very unstable, that it is easily decomposed. The composition of this and other similar bodies, will be treated of fully in a future article. The property which oxygen has

of combining with two atoms of hydrogen, has been called its atomicity, and oxygen has been termed diatomic. This word certainly does not express the property, for it is not the oxygen which is di-atomic, the oxygen is but one atom, it is truly mon-atomic, but it has the property which enables it to hold two atoms of hydrogen in combination, and which will not permit it to hold less than two of this element, or of an element similar to hydrogen, as potassium, or one atom of hydrogen together with one of a similar element. The compound HO when $H = 1$ and $O = 16$ cannot exist in the free state. Various words have been suggested to express this power. Some have proposed to call it dynamicity, but Professor Williamson in his lectures at University College, advises the use of the word valency or valence instead of atomicity, and this really seems to express what conceptions can be formed of this property of elements. Adopting this suggestion, oxygen would be termed divalent in water, nitrogen trivalent in ammonia NH_3, and carbon tetravalent in marsh gas CH_4. Experiment proves that elements combine with one another in various proportions, for example, oxygen combines with nitrogen in five different proportions.

Nitrous oxide N_2O.
Nitric oxide N_2O_2.
Nitrous acid N_2O_3.
Peroxide of nitrogen N_2O_4.
Anhydrous nitric acid N_2O_5.

Somewhat similar compounds are formed by oxygen and chlorine, but in all these cases the combinations take place in the proportion of multiples of the atomic weights of the different elements. It was from these facts that Dalton framed his law of multiple proportions, and assuming his definition of an atom to be correct, no different combining proportions can exist, and none others have been discovered by experiment than 28 of nitrogen to 16 of oxygen in N_2O; 28 : 32 in N_2O_2; 28 : 48 in N_2O_3; 28 : 64 in N_2O_4; and 28 : 80 in N_2O_5. In carbonic oxide, oxygen combines with carbon in the proportion of sixteen to twelve, in carbonic acid in that of thirty-two to sixteen. In these compounds, containing different proportions of the same elements, distinctly different properties are observed. Nitrous oxide supports combustion like oxygen, but less energetically; nitric oxide does not—it, however, takes up oxygen readily, and forms a red coloured gas which has acid properties, uniting with bases to form salts. Per-

oxide of nitrogen is a red gas, which does not enter into such combinations, and anhydrous nitric acid in the presence of water, becomes nitric acid. Carbonic oxide burns, takes up oxygen to form carbonic acid, and destroys life as a poison, while carbonic acid neither burns, nor supports combustion, except under certain circumstances, as when potassium is oxidized in it, and destroys life by excluding oxygen. A difficulty may arise here which, perhaps, ought to be noticed before proceeding further. If the elements have the power of combining with one another in definite proportions, how comes it that if oxygen is divalent, and nitrogen trivalent, such compounds exist as those just referred to, in which oxygen combines in such different proportions with nitrogen and carbon (the proportions, however, still being in multiples of their atomic weights). To take the case of carbon, it forms two oxides, carbonic oxide CO, and carbonic acid CO_2; carbon is tetravalent, oxygen is divalent. In carbonic oxide, one atom of tetravalent carbon is combined with one atom of divalent oxygen; in carbonic acid, one atom of tetravalent carbon is combined with two atoms of divalent oxygen. In carbonic oxide it is supposed that the oxygen satisfies the carbon to the extent of half its combining energy, and that the remaining carbon satisfies itself. Suppose that the atom of carbon has a combining force which is represented by four, and is equal to the force of four atoms of hydrogen, each being equal to one, and that it is satisfied by them as in marsh gas CH_4. Now oxygen has a force which is equal to that of two atoms of hydrogen, and is satisfied by them, as in water, H_2O. If one atom of oxygen be combined with one atom of carbon, its two forces will neutralize or satisfy two of the forces possessed by the atom of carbon, but there will still remain in the carbon two forces unsatisfied, and these are considered in such combinations to satisfy one another. This explanation is introduced here, though it properly belongs to a more advanced consideration of the subject, because the writer felt this difficulty, in his earlier chemical studies, to be one, which rendered obscure many points which might have been, in a great measure, cleared up, had he been aware of the way in which chemists regarded chemical combinations. In carbonic acid the atom of carbon is completely satisfied by the two atoms of oxygen, as is the oxygen by the two atoms of hydrogen in water, no further oxidation of the carbon can take place; but in carbonic oxide, where only half the carbon is satisfied by oxygen, and where carbon in part satisfies itself, there is a readiness, so to speak, to take up another atom of oxygen, whereas if a compound is saturated,

it is difficult in all cases to cause further addition of an atom of its constituent elements, as in H_2O_2, and in many cases it is impossible, as in CO_2. It is not necessary to consider the case of the oxides of nitrogen at present, as this branch of the subject will be treated at length in its proper place.

A combination of two or, in some cases, more atoms is called a molecule, H_2O is a molecule of water, NH_3 of ammonia, and CH_4 of marsh gas; and the molecule is defined to be the smallest quantity of a compound or element, which can exist by itself. The atom, the smallest quantity of an element which is known to take part in a reaction, is only known in the combined state* $O=16$ means oxygen in combination, free oxygen is represented by $O_2=32$ and O_2 is called its molecule; in like manner $H_2=2$, $Cl_2=71$ represent the molecules of hydrogen and chlorine, that is when they are set free from combinations in which they existed; for example in HCl hydrochloric acid, H is an atom of hydrogen, and is equal to I, but if HCl be acted upon by zinc, two atoms of hydrogen are expelled by it from the hydrochloric acid, and from H_2 the molecule of hydrogen, the zinc entering into combination with the chlorine thus—

$$2\,(H\,Cl) + Zn = Zn\,Cl_2 + H_2;$$

but, if instead of zinc, which is divalent, a monovalent metal as sodium be taken, the decomposition should be represented thus—

$$2\,H\,Cl + 2\,Na = 2\,(Na\,Cl + H_2).$$

It would not be correct to take one atom of sodium, for one atom of hydrogen could not re-act, as no less a quantity of hydrogen can exist in the free state than H_2.†

The molecular weight of a compound is made up of the sum of the weights of its atoms. The molecular weight of water, H_2O is $2+16=18$, of sulphuric acid, H_2So_4 $2+32+64=98$, of nitric acid, HNO_3 $1+14+48=63$. The molecular weight of anhydrous nitric acid, N_2O_5 is $28+80=108$, if to this be added a molecule of water, H_2O, nitric acid is formed—

$$N_2O_5 + H_2O = H_2N_2O_6.$$

* The word element here includes elements proper, and bodies which, though compound, behave as elements, such as cyanogen CN, ammonium NH_4; and the statement cannot apply to elements, where the atom and molecule are identical, as in the case of mercury.

† At the commencement of this article, decompositions are represented, in which only one atom of hydrogen is set free. This is in general an incorrect method of stating such a reaction, it is here used simply to prevent confusion and complication by doubling the molecule.

Why then is not $H_2N_2O_6$ the molecule of nitric acid, and not HNO_3? It is found by experiment that potassium or sodium, which are both mon-equivalent with hydrogen, replace that element in nitric acid in one proportion only, that is, they form but one nitrate KNO_3 and $NaNO_3$, and that no such compound as $KHNO_3$ or $NaHNO_3$ or K_2NO_3 or Na_2NO_3 exists, also that when a divalent element, as baryta, forms a nitrate, its composition is Ba $2(NO_3)$; from which it is concluded that the molecule of nitric acid contains only one atom of hydrogen, and is properly represented by the formula HNO_3. In like manner it is shown that the molecule of oxalic acid has the formula $H_2C_2O_4$, not HCO_2, both the atoms of hydrogen being capable of replacement by potassium or sodium, thus we get KHC_2O_4 and $K_2C_2O_4$; also $NaHC_2O_4$ and $Na_2C_2O_4$. In sulphuric acid, as in oxalic, both the atoms of hydrogen can be replaced by potassium severally or together, as in $KHSO_4$, commonly called bisulphate of potash, and in K_2SO_4 sulphate of potash, or by a divalent element as calcium, forming $CaSO_4$. The number of atoms of hydrogen which can be replaced by other elements, or by compounds which act as elements, determine the *molecular constitution* of a body, and therefore its *molecular weight.* Many of the elements and their compounds exist in the gaseous state, as oxygen and carbonic acid; some can be brought into that state by heat, those which are compounds without decomposition, as mercury and water; some cannot be volatilized at all, as carbon; and others are decomposed when heated, before they are vapourised. All gases, whether elementary or compound, expand equally for equal increase of temperature, for example—hydrogen and water-vapour, when not in contact with water, expand regularly 0.003665 of their bulk for every degree centrigrade rise of temperature; the same amount of pressure equally diminishes their volume; and the elastic force which their particles exert against whatever restrains their efforts to expand, is the same, provided they are at the same temperature and under the same pressure. This fact has been explained by Avogadro, on the supposition that, in equal volumes of gases there is an equal number of molecules. When hydrogen and oxygen combine to form water, two molecules of hydrogen and one of oxygen, at least, must take part in the reaction, H_2, H_2 and O_2, three molecules; and these, after combination form H_2O, H_2O, two molecules. If four litres* of hydrogen be mixed with two litres of oxygen, and the mixture be exploded, the product, in the state of vapour, will measure four litres, six volumes of the mixed gases being condensed to four of

* A litre is equal to 1,760773 English pints.

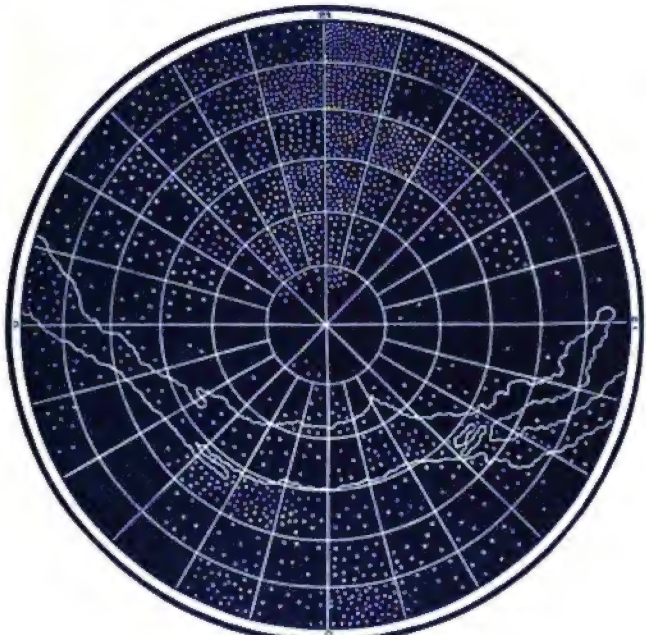
the compound, the condensation in volume being in proportion to the reduction in the number of the molecules. In ammonia, three molecules of hydrogen re-act on one of nitrogen, H_2, H_2, H_2, and N_2, the ammonia formed by their combination is NH_3, NH_3, two molecules; here four molecules have become two, and if measured volumes be taken, for example, six litres of hydrogen, and two of nitrogen, the ammonia gas resulting from their combination will measure four litres. In like manner it can be shown that the same results are obtained where the molecules are of a more complex character. Equal volumes of elements and compounds in the gaseous state, contain an equal number of molecules, and this hypothesis renders it easy to understand how condensation in volume takes place between mixed gases or vapours, when they become chemically combined. The molecules of all chemical compounds, with very few exceptions, occupy, when in the state of vapour, two volumes, that is, they occupy the same volume as the molecule of one of their constituent elements; for example CH_4, marsh gas, occupies two volumes, and hydrogen, one of its constituents, in the free state is H_2, and occupies two volumes. Olefiant gas, C_2H_4, occupies the same volume as H_2, and this is true of the complex molecules of organic bodies. This law of vapour-volumes has assisted in determining the atomic weights of certain elements. For a long time it was doubtful whether the atomic weight of zinc was 65 or half that number. When zinc ethyl was made, and its vapour-volume taken, it was found that ZnC_4H_{10} occupied two volumes, and was therefore its molecule, and that it contained zinc in the proportion of 65 parts of zinc to one of hydrogen, the atomic weight of zinc was therefore fixed at 65. From the fact that the molecule in the state of vapour occupies two volumes, it is easy to arrive at the density of any compound with respect to hydrogen; for if CH_4, in the vapour state, occupies two volumes, and if the molecular weight of a compound is the sum of the atomic weights of the elements composing its molecule; the molecular weight of $C\ H_4$ will be $C=2$, $H_4=4$ $C\ H_4=12+4=16=$two volumes. Now the molecule of hydrogen is $H_2=2$ therefore the molecular weight of marsh gas is to the molecular weight of hydrogen as 2 : 16.

If we now take the atomic weight of hydrogen to be one, the weight of marsh gas compared with hydrogen, or its density, is eight, and in this simple way the density of any compound body may be arrived at, *add together the atomic weights of the constituent elements, and divide their sum by two, the result gives the density required.* In the case of elements, their densities are the same as their atomic

weights, the molecule of hydrogen, H_2, occupies the same volume as the molecule of chlorine, which is Cl_2, that of hydrogen = 2, that of chlorine = 71, and therefore the molecule of hydrogen is to the molecule of chlorine as 2 : 71, and therefore the atom of hydrogen is to the atom of chlorine as 1 : 35·5, which is the atomic weight of chlorine. The same is true of oxygen, nitrogen, and all the other elements with a few exceptions. Some elements, however, combine without condensation of volume. Chlorine, bromine, iodine, and fluorine combine with hydrogen volume for volume, the molecules of the resulting gases, hydrochloric, hydrobromic, hydriodic, and hydrofluoric acids occupying two volumes, and their densities, on the hydrogen scale, are half the sums of the atomic weights comprising their respective molecules; therefore one volume of hydrogen and one of chlorine form two volumes of hydrochloric acid, whose density is $\frac{1 + 35 \cdot 5}{2} = 18 \cdot 25$; one volume of hydrogen and one of bromine form two volumes of hydro-bromic acid, whose density is $\frac{1 + 80}{2} = 40 \cdot 5$; one volume of hydrogen and one of iodine form two volumes of hydriodic acid, whose density is $\frac{1 + 12 \cdot 7}{2} = 64$; and one volume of hydrogen and one of fluorine form two volumes of hydrofluoric acid, whose density is $\frac{1 + 19}{2} = 10$. There are, however, some exceptions to this law, which, for a time, were without explanation. Chloride of ammonium, NH_4Cl, or hydrochlorate of ammonia, NH_3HCl, the same substance differently named, according to the view which is taken of its constitution, was found to occupy four volumes in the state of vapour. The anomaly has been explained in this way: When heated, the chloride breaks up into hydrochloric acid and ammonia, so that the molecule of each of these bodies occupies its own vapour-volume; *i.e.*, two volumes, and they together occupy four volumes; and that when cooled again they enter into combination. This view was not at first generally received. M. Deville performed several experiments to prove that chloride of ammonium is not decomposed by the heat sufficient for its vaporization. He caused hydrochloric acid gas and ammonia to unite, *with evolution of heat*, at a temperature of 350° Cent., the temperature at which the vapour density of chloride of ammonium is four volumes, and from this he argued that if union took place at that temperature, decomposition could not; but M. Lieben showed that decomposition might take place, but not completely,

that, if the products of decomposition remain in contact with the substance which is being decomposed, a small quantity of it remains undecomposed, and he argued that, if the separate gases were mixed at the same temperature, they would remain almost entirely free, only a small quantity uniting, and that this union would be attended with evolution of heat; he therefore concluded that the small quantity of chloride of ammonium formed, could not materially influence the vapour-density determination. Experiments subsequently made by M. Wurtz on other similar compounds, have confirmed M. Lieben's views. Sulphuric acid H_2SO_4 also gives an anomalous vapour-density, its molecule occupying, in the vapour state, four volumes. Here, as in the case of chloride of ammonium, the H_2SO_4 has been found to break up into water H_2O, and a hydrous sulphuric acid SO_3, each molecule occupying its proper two volumes. When, however, chloride of ammonium and sulphuric acid are heated to a temperature below that at which they decompose, their molecules respectively occupy two volumes. There are other substances which give anomalous vapour-volumes, nitric oxide N_2O_2 = four volumes, and peroxide of nitrogen N_2O_4 = four volumes; this latter compound has however been found to occupy two volumes when its density has been taken at a lower temperature. Among the elements, phosphorus, arsenic, and mercury show some irregularities. The atomic weight of phosphorus is thirty-one, and four of its atoms, in a state of vapour, occupy two volumes, its density therefore, is double its atomic weight, viz., sixty-two. Arsenic has an atomic weight seventy-five, and its molecule contains four atoms in the state of vapour, its density, therefore, is 150. The atomic weight of mercury is found to be 200, and Hg = 200 = two volumes; therefore the atom and the molecule are the same, and the vapour density of mercury is 100. If it were not for these exceptions, the vapour-volume of any molecule would be a perfect confirmation of its molecular weight; as it is, the molecular weights of all compounds whose vapour-densities obey the general law, may be relied upon as being perfectly accurate.

Fig. 1.—Illustrating the Distribution of the Northern Nebulæ.



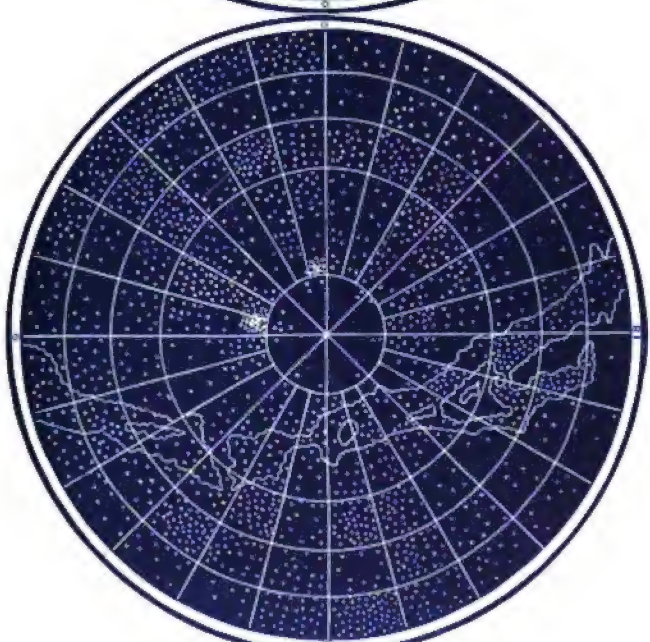


Fig. 2.—Illustrating the Distribution of the Southern Nebulæ.

NOTES ON NEBULÆ.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

(*With a Tinted Plate.*)

INCLUDING both hemispheres, there are visible to the naked eye, under the most favourable circumstances, about 5000, or at the most 6000 fixed stars. If these and the fixed stars visible in the most powerful telescopes were to disappear, and the eye to acquire the light-gathering power of Herschel's 20-feet reflector, there would be seen scattered over the vault of heaven—instead of the fixed stars now visible—about as many nebulæ—"feebly shining, cloud-like patches, often of strange and fantastic forms."

The faint illumination of nebulæ, the close crowding of stars in many that are resolvable, and other circumstances, have appeared to confirm the view that these objects shine from distances far beyond those of the farthest fixed stars. It has been considered that nebulæ are (for the most part, at least) aggregations of suns ("island-universes," as a German philosopher has expressively termed them), forming galaxies similar to our own "Milky Way," and reduced, notwithstanding the immensity of their dimensions, by a yet greater immensity of distance, to the appearance of faint specks of light, which the slightest haze in our skies is sufficient to conceal from us. The important discoveries effected by Mr. Huggins, which have shown that many nebulæ are gaseous in composition—nineteen out of sixty observed presenting the spectrum of bright lines separated by dark spaces which indicates the gaseity of the source of light—have modified these views. Without giving absolute support to the speculations of Sir W. Herschel, respecting the condition and changes of condition of nebulæ, Huggins' discoveries show that the views on which Herschel founded his speculations were well grounded. The distinctions Herschel drew between the different classes of nebulæ have been confirmed, so far as spectrum analysis has yet proceeded—every planetary nebula yet observed, for instance, has been proved to be gaseous. The process of generalization, which had been commenced by many eminent astronomers, and in which scarcely any distinctions but those depending on the resolvability of nebulæ were recognized, has been abruptly checked. It is to be noticed, however, that many German astronomers, and some, at least, of our most distinguished English

observers (amongst others, the late Admiral Smyth) had looked with more than doubt on the view that, with sufficient optical power, all nebulæ are resolvable into stars.

It is clear that Huggins' discoveries affect, not merely the views we must form of the constitution of nebulæ, but our ideas of the distances at which these objects are placed, and, therefore, of their true magnitudes. It is with such considerations as are suggested by modern discoveries, and with others for which the overthrow of opinions lately thought well-established seems to leave room, that I wish now to deal. Anything like a discussion of the *general* subject of nebulæ, a sketch, however brief, of the history of their discovery, or an account of particular nebulæ (save in illustration of the considerations I have to deal with), would be wholly out of place in these pages—especially since the readers of the INTELLECTUAL OBSERVER received, in many papers of interest, full information on these and kindred branches of the subject.

The first point I shall dwell upon is the distribution of nebulæ over the heavens. In the present state of our knowledge, it would not be convenient to particularize classes of nebulæ in considering this point—though, as we shall presently see, there are one or two circumstances in this connection which cannot be wholly neglected.

Sir John Herschel, in order to form a clear conception of the distribution of nebulæ over the celestial sphere, adopted a plan similar to that illustrated in Figs. 1 and 2 (see plate). But he represented the number of nebulæ falling in each space by numbers —a method which does not serve to present very clearly the distribution of nebulæ. In Figs. 1 and 2, I have indicated the number of nebulæ falling in each space by dotting. Let us consider what evidence the maps seem to present of orderly distribution.

In Fig. 1, there will be observed a very decided clustering in the region between 11h. and 14h. of R.A. This is the nebular region in Virgo, extending over Coma Berenices, and the tail of Leo, curving (to the right in our figure) over Canes Venatici, thence (to the left) over the tail and hind quarters of Ursa Major, to within about 12° of the pole near the tail of Draco. The borders of this stream or cluster of nebulæ extend dispersedly over the two Leones, Cancer, Gemini, Lynx, and Ursa Major on one side (the left in our figure), and over Bootes and Corona on the other. As there seems to be a decided break in the stream—or rather, perhaps, as the stream decidedly comes to an end near the pole—we must return to the point from which we commenced, the upper part of Fig. 1; and thence, to look for the continuance of the stream in the

contrary direction, we must look to the lowest point of Fig. 2.* Here we find a continuation of the stream, which presently divides into two, the right hand stream passing over the left hand of Virgo, the tail of Hydra, and nearly the whole extent of Centaurus, to Crux and Musca; the left-hand stream passing over Crater, to Antlia, and the mast and sails of Argo. The gap which bounds the northern group seems continued, but not in quite so marked a manner, by the space comparatively clear of nebulæ which runs round the right-hand stream (of the two just described) across the pole, and thence to a point a little above the extreme left of Fig. 2. Returning to Fig. 1, we notice a less distinctly marked grouping over part of Perseus and Andromeda, passing (to the right) over the square in Pegasus to the southernmost of Pisces, and (to the left) over the band in Pisces, across Cetus (in the upper left-hand quadrant of Fig. 2), Eridanus, and Dorado, in a distinctly-marked stream leading to the Nubecula Major. The right-hand stream, which we had followed as far as Pisces, seems to have a continuation towards the Nubecula Minor, and also to throw out a convolution over the tail of Piscis Australis, over Indus et Pavo, towards Apus and Musca.

There remains to be noticed a clustering of nebulæ towards the right hand portion of the Milky Way in Fig. 2. Sir John Herschel considers that many of these nebulæ belong to the Milky Way, as they are wanting in the gap between the two branches of the galaxy in this neighbourhood.

The first inquiry which suggests itself, on a review of the distribution of nebulæ, is the question, whether there is any indication of a connection between nebulæ and fixed stars? The theory that nebulæ are galaxies similar to our own Milky Way would, of course, require that we should dissociate nebulæ from any connection with our galaxy, save a relation corresponding to that which holds between the fixed stars and the sun. And further, although it would not be impossible that a tendency to systematic arrangement should be apparent among the nebulæ, yet the distances separating nebula from nebula would (on this theory) be so vast, compared with the distances separating star from star, or even with the dimensions of our galaxy, that it would clearly be very improbable that such

* There is a slight inaccuracy in Sir J. Herschel's maps. The southern map is correctly presented, but in the northern the order of R.A.'s is inverted. This renders the comparison of the map with a celestial atlas inconvenient. Figs. 1 and 2 are so arranged that, if closed one upon the other, the corresponding parts of the circumference of each would be brought together.

arrangement should be discernible by terrestrial astronomers. As, however, the theory is very generally held, I shall present, as I proceed, some considerations which seem opposed to it. We seem, rather, to have evidence that most of the nebulæ—if not all of them—are much nearer to us than has been commonly maintained. I must observe, however, that my object is neither to establish nor to overthrow theories, but merely to note some of the salient points of the subject in hand, which have, as it seems to me, been unduly neglected in our works on Popular Astronomy.

Sir J. Herschel, after presenting the chief features of the distribution of nebulæ, remarks that "the general conclusion which may be drawn from the survey is, that the nebulous system is distinct from the sidereal, though involving, and, perhaps, to a certain extent, intermixed with the latter." Setting aside the "band of clusters" near Scorpio, already referred to, he considers that the distribution of nebulæ is explained by considering the nebular region in Virgo to be the central condensation of a spherical (roughly speaking) cluster of nebulæ; that our system lies outside the denser part of the cluster, but is "involved within its outlying members," or "forms an element of some one of its protuberances or branches, of which the individuals are the sporadic nebulæ confusedly scattered over the general surface of the heavens, and of which the prolongation towards the constellation Pisces may give rise to the apparently denser grouping of the nebulæ in that region."

To me these views appear wholly untenable, and I feel the less diffidence in expressing dissent from so high an authority as Sir J. Herschel, because he has elsewhere expressed opinions which show that he held the above theory by but a light grasp. If the dense mass of a cluster of nebulæ lay in one direction, and but outlying branches in the other, the number of nebulæ seen in the former direction should overwhelmingly exceed the number seen in the other; whereas, at the outside, the proportion in the actual case is but as two to one, and even this excess is no doubt partly due to the fact that the southern hemisphere has been less thoroughly searched than the northern. And neither this view, nor the other solution suggested by Herschel, explains the existence of a zone of the celestial hemisphere in which nebulæ are markedly wanting. If our system were placed within a *narrow* branch, or protuberance, of a nebular system, the cluster in Cetus should be smaller than it is; if, on the other hand, the branch were of such dimensions as our conception of the distances of nebulæ would lead us to expect,

there would not be wanting nebulæ on every side of us. These, however, are not the objections on which I would mainly dwell. I shall be able to show, I think, that the appearance of nebulæ, and the relations they present to the fixed stars, are opposed to the view that they form an independent system, of which our galaxy is but a member.

Singularly enough, Sir J. Herschel immediately after exhibiting the views presented above, quotes (and as if in corroboration) an opinion of his father's, which is very strongly opposed to those views. He says, "It must not be left out of consideration, and has been distinctly remarked by Sir W. Herschel, as an element of whatever speculation a closer attention to this subject, and a more perfect classification of nebular objects may lead us to indulge in, that the most condensed portion, and what may fairly be regarded as the principal nucleus of the region of Virgo, is situated almost precisely in one pole of the Milky Way." Why, it may be asked, should the nebulæ, supposing they really form a system of which our galaxy is but a member, show any tendency to aggregation about either pole of the Milky Way? Assuming our galaxy to be but a member of a supposed nebulous system, to *expect* any relation of the kind described would be as unreasonable as it would be for an astronomer on Saturn to look for a connection between the arrangement of the fixed stars, and the apparent position of the Saturnian rings upon the celestial firmament. And therefore, if such an arrangement is actually observed, it must be accepted either as accidental—in which case it is clearly not necessary to consider it in forming a theory of the nebulæ; or else we must view the arrangement as an evidence of a closer connection between the nebular system and the Milky Way than is commonly assumed to exist.

Tracing the group or stream whose condensed region is in Virgo from its commencement near the tail of Draco, we find that it crosses a region rich in small stars and double stars. Coma Berenices, a constellation which may almost be termed a star-cluster, is rich in nebulæ. But Ursa Major, a region of the heavens of exactly opposite character—a region in which many brilliant stars shine on a background which in places appears (to me at least) of unusual blackness—includes also a rich part of the nebular stream. Leo Minor exhibits several small stars, but in this constellation nebulæ are rich where small stars (fourth magnitude) are wanting. In this neighbourhood the background may almost be termed nebulous. The rich nebular cluster in Virgo lies on that part of

the constellation which borders on Coma Berenices. The region is surrounded on every hand by stars of the third and fourth magnitude, but over the region itself stars are rather markedly absent. Crossing the equator, we find that the stream shows a decided preference for regions in which visible stars are scarce. Thus over Corvus and Crater, where lucid stars are closely clustered, there is a gap in the nebular stream, and the rich cluster near the break in the Milky Way occupies the blank region mentioned in my paper on star-streams in the INTELLECTUAL OBSERVER—a region than which there is none more desolate (so far as lucid stars are concerned) in the whole heavens. The neighbouring region, crossed by the brightest part of the Milky Way, and by a brilliant array of lucid stars, exhibits but few nebulæ.

Turning to the less-marked nebular cluster, whose greatest condensation is in Cetus, we find in its northern part a rich display of nebulæ over parts of Perseus and Andromeda, in (or around) which lucid stars are thickly clustered. Near the equator (on the southern side) we find nebulæ distributed richly over a region in which are many stars of all magnitudes, including many double-stars, and one noted variable. Of the two streams into which the nebular system here divides, one follows the windings of Eridanus, with an apparent preference for the spaces clear of stars, around which that star-stream travels; the other forms itself into a cluster which occupies a space almost as blank of lucid stars as that between Hydra and the Milky Way.

When we consider those regions of the heavens in which nebulæ are markedly deficient, we find an arrangement which cannot be wholly accidental. I refer to the zone, very marked in the northern hemisphere, and not indistinctly traceable in the southern, which has been already described. This zone is not quite coincident, in direction, with the Milky Way, but follows almost exactly a circular band, which includes more lucid stars than any corresponding band on the heavens. In fact, if we neglect nebulæ, which may fairly be considered to belong to the Milky Way itself, we may fairly say that the zone includes Canis Major, Orion, Taurus, Auriga, Perseus, Cassiopeia, the richer parts of Cepheus and Draco, Lyra, Scorpio, and finally, the rich region in Argo already mentioned.

Now, it appears to me that those who have speculated on the subject of nebulæ have been too apt to content themselves by looking for zones and streams of aggregation, not noticing apparently that zones along which nebulæ are sparingly dis-

tributed, may be as marked indications of systematic distribution as zones of aggregation. I consider that the zone mentioned in the preceding paragraph is a phenomenon scarcely less distinct in character than the zone of the Milky Way itself; and I look on the connection between the former zone and the zone of brilliant stars as a very noteworthy circumstance.

I may remark in this connection that much less stress has been laid on the peculiarity that scarcely a single lucid star occurs within the gaps and cavities in the Milky Way than the nature of the phenomenon fairly warrants. While stars are clustered in the borders of these spaces, *within* there is such a vacancy that one cavity is called the Coalsack, another is called by Sir W. Herschel an opening into space, and Sir John Herschel, speaking of the vacant region near α Centauri, tells us that in his powerful telescope he found several fields wholly blank. There is not a single star of greater magnitude than the fifth within a cavity in the Milky Way, or between the two streams where the galaxy is double; and there are not ten stars of the fifth magnitude so situated. This will appear the more remarkable when we remember that, according to the stratum theory of the Milky Way, these regions ought to be very rich in stars of all magnitudes.

It has been already noted by astronomers that all nebulæ of irregular form and great extent are found along a zone nearly coinciding in direction with the Milky Way. The great circle along which such nebulæ are actually found is, in fact, no other than that along which nebulæ in general are conspicuously wanting. It is also worth noticing that where this zone, and the zone of the Milky Way intersect, we find the singular nebula round η Argus in one hemisphere, and in the other the remarkable nebular region in Cygnus.

The discovery that the great irregular nebula in Orion is gaseous, renders it probable that the other irregular nebulæ are so likewise. Whether they are so or not, it is clear that they are totally different in character from regular nebulæ. Therefore, we may look on their aggregation on the great circle along which few nebulæ are found, as a circumstance (1) not opposed to the evidence of systematic distribution founded on that peculiarity; (2) as itself indicative of arrangement associating nebulæ with the stellar system.

One peculiarity of the irregular nebulæ deserves to be especially dwelt upon. All of them exhibit a tendency to arrange themselves around fixed stars. Consider, first, the nebula in Argo.

In the first place, there is the actual aggregation of stars near the very region of the nebula—a fact which is *per se* remarkable, though not alone sufficient to indicate the connection I am seeking to exhibit. "It is not easy," says Sir J. Herschel, "for language to convey a full impression of the beauty and sublimity of the spectacle which this nebula offers, as it enters the field of view of a telescope fixed in Right Ascension, by the diurnal motion, ushered in as it is by so glorious and innumerable a procession of bright stars *to which it forms a sort of climax.*" "*One other bright and very remarkably formed nebula of considerable magnitude precedes it nearly on the same parallel, but without any traceable connection between them.*" I have italicized this last quotation, (1) because it points to a phenomenon observed in all the irregular nebulæ, of associated but not always distinctly connected nebulæ; (2) because the association of *two* irregular nebulæ with the same stream of bright stars is well worthy of attentive notice.

But it is when we examine the features of the nebula that its association with the starry background becomes most clearly apparent. In the small map of the nebula given in Herschel's Astronomy the relation is not satisfactorily presented, but in the large map of which the former is a reduction, we find the following peculiarities:—

The central and most condensed part of the nebula exhibits a vacuity of singular, but regular form, described by Herschel as a lemniscate-oval, but in reality more complex than this description implies. The brilliancy of the nebulæ is much greater on one side of this vacuity than on the other. In the middle of the bright region is situate the remarkable variable η Argus—a star marked in Halley's Catalogue as of the fourth magnitude, but which has been known to surpass Canopus, and even to approach Sirius in magnitude. Around the vacuity there are marked in no less than twelve stars either exactly on, or very close to the border. One of these is just within the vacuity; but besides this star, which may fairly be termed a border-star, there is not a single star within the opening. On the other hand there may be counted, besides the twelve stars above named, no less than fifty-four stars on the nebulous region around the opening. From the central part of the nebula, there extend a number of nebulous streams, "of whose capricious forms and irregular gradations it would be impossible to give any just idea." But one peculiarity is noticeable throughout the convolutions and contortions of these irregular streams—viz., that *on* the nebulous portions stars are common, on the parts *clear*

of nebula stars are either wholly wanting or very sparingly distributed. And those stars which do occur in apparently blank regions, yet appear evidently associated with nebulous streams and projections pointing directly towards them. The connection is so marked, that I cannot understand how it can have escaped the notice of so sagacious an observer as Herschel; or rather how noticing the phenomenon, he should not have recognized the evidence it afforded of a connection between the nebula and the fixed stars seen in the same field. There is not a single remarkable condensation or projection in the nebula which is not marked by bright or clustering stars, by stars which appear clearly to be *leading stars*, and there are not ten stars out of some hundreds entered, whose influence on the nebula is not clearly discernible. If the fainter portions of the nebula were examined with more powerful telescopes, I believe that even these stars would be found to be associated with the nebula.

As respects the great nebula in Orion, I remark that while the proportion of stars whose connection with the nebula has not been traced is somewhat greater, yet nearly every marked condensation in the nebula is associated with conspicuous stars (that is, with stars conspicuous among those visible in the same field of view with the nebula). Every telescopist also is familiar with the fact, that the central condensation of the nebula clusters round the trapezium of stars, within which there is either no nebulous light or very little. The association is not likely to be an accidental one. Herschel himself remarks that the star ϵ Orionis is involved in strong nebulosity, "probably connected with the great nebula," while he was able to trace a faint extension of the nebula as far as the double star ι Orionis, which it involves and renders nebulous.

Turn we now to the region of irregular nebulæ of Sagittarius. The first nebula mentioned by Sir J. Herschel is described by him as "singularly trifid, consisting of three bright and irregularly formed nebulous masses, graduating away insensibly externally, but coming up to a great intensity of light at their interior edges, where they enclose and surround a sort of three-forked rift, or vacant area, abruptly and uncouthly crooked, and quite void of nebulous light. A beautiful triple star is situated *precisely* on the edge of one of these nebulous masses, just where the interior vacancy forks out into two channels. A fourth nebulous mass spreads like a fan or downy plume *from a star*, at a little distance from the triple nebula." Another (δ Messier), he describes as "a collection of nebulous folds and masses, surrounding and

including a number of oval dark vacancies, and in one place coming up to so great a degree of brightness, as to offer the appearance of an elongated nucleus. *Superposed upon this nebula, and extending in one direction beyond its area, is a fine and rich cluster of scattered stars, which seem to have no connection with it, as the nebula does not, as in the region of Orion, show any tendency to congregate about the stars."* Herschel gives a view, however, of the nebula and star-cluster which, it is not too much to say, is wholly irreconcilable with the opinions here expressed. Not only are the two brightest stars of the cluster placed exactly upon the "elongated nucleus," but every "fold and mass" of the nebula is associated with a region of greater richness in the cluster.

As respects the fourth and last nebula, that of Cygnus, I may simply quote Sir J. Herschel. He describes the region as "consisting, first, of a long, narrow, curved, and forked streak, and, secondly, of a cellular effusion of great extent, *in which the nebula occurs intermixed with, and adhering to, stars around the borders of the cells, while their interior is free from nebula, and almost so from stars."*

I have already drawn out this paper to a much greater length than I had proposed, and yet have seemed scarcely to have entered upon my subject. Let me, instead of proceeding to treat cursorily of the remaining branches of that subject, here pause and "report progress." We have found a law of aggregation of nebulæ in regions removed from the Milky Way, and thus a law of contrast, which amounts in reality to a law of connection between nebulæ and the starry system. We have found that, in the southern hemisphere, this law of contrast is further exhibited in an aggregation of nebulæ over regions in which stars are wanting, and *vice versâ;* lastly, we have seen that over a *zone* of the heavens in which nebulæ are all but absolutely wanting, there is a marked aggregation of lucid stars, that on the same zone all the irregular nebulæ are collected, and that these irregular nebulæ, all occurring in regions very richly bestrewn with fixed stars, exhibit in their configuration a correspondence with the configuration of the fixed stars in the same field, which cannot be wholly accidental.

WHITE'S MASSACRE OF ST. BARTHOLOMEW.*

The Massacre of St. Bartholomew, though well known as one of the most fearful tragedies which history records, is rarely contemplated from a philosophical point of view. Amongst Protestants it is usually regarded as an awful illustration of the persecuting spirit of the Romish church, and little attention is paid to its political character, or to the long series of circumstances, social and political, as well as theological, by which it was brought about. It is curious to note how a particular incident of this kind occupies a position in the thoughts of a Protestant country like England, almost to the exclusion of many similar incidents of equal atrocity and of more sanguinary extent. The French massacre was exceeded in deliberate wickedness and surpassed in magnitude by the atrocities of the Duke of Alva in the Low Countries, but yet millions reflect with horror upon the St. Bartholomew slaughter, while only scores or hundreds thought much about the sufferings of the Dutch and the Flemings till Motley took up their tale. The Thirty Years' War in Germany, again, was one continued massacre on the Papal side, in which the worst incidents of St. Bartholomew were frequently rivalled or exceeded; but, though Germans still stand aghast at the destructive ferocity of carnage-loving Tilly, in English eyes he is eclipsed by the guilt of Catherine de Medici and Charles IX.

There is, after all, some rude justice in the way in which St. Bartholomew's Day is thus exalted in horror by the Protestantism of our country, for it was doubtless a day of tremendous importance for France and for the cause of the Reformation in that land. Though supported by a powerful party at the time of the massacre, the Protestant cause in France could not afford the loss of so many of its bravest spirits and leading minds. But for that day of too-successful assassination, Henry of Navarre might not have found himself compelled to submit to conversion as the only means which appeared open to him of restoring peace to France, and, but for that day, another day of evil for our neighbours, that on which the Edict of Nantes was revoked, might never have cast its blighting influence upon them, and indirectly led to the substitution of tempestuous revolution for the quiet development of reform. In every age and country there are a few persons who stand in so peculiar a

* "The Massacre of St. Bartholomew, preceded by a History of the Religious Wars in the Reign of Charles IX." By Henry White. Murray.

relation to its progress, that if they are swept away retrogression takes place; and, although the Roman Catholic community of France has never failed to supply great and good men, it is not too much to say that the slaughter of Protestants at one period, and their expulsion at another, threw the country backwards, and left it in a condition which entailed struggles and disasters which the present Empire is evidently not destined to end.

Charles IX. and Catherine de Medici are commonly accepted as types of cruelty and fraud, and yet, when their history is more fairly surveyed, it might almost tempt some daring and whitewashing historian to claim for them no small amount of sympathy, and remove a load of obloquy from their names. Dr. White has not attempted this task, and we are glad of it, for, though he might have made out as plausible a case as other writers have done on behalf of equally damaged reputations, the result would not be nearer the truth than the black picture which popular imagination delights to paint.

Individual guilt must depend upon circumstances of which men can very imperfectly judge. There are thousands of ordinarily good people who would behave very badly if placed in situations offering strong inducements to go wrong, and slender guidance to act right. Catherine and her son had no bigotted hatred of the Reformed faith. They were not cruel in the ordinary sense of the word—that is, not more so than was customary in an age when bloodshed was incessant, punishments ferocious, and suffering so common as to attract little heed. There were periods in the career of both when, if the political conditions under which they ruled had been more favourable, they would probably have either established Protestantism as a state religion, or secured for it full toleration; and, had they done so, their names might have gone down to posterity as amongst the most excellent specimens of their class, though they would only have acted upon the same class of motives which, under unfavourable circumstances, steeped them in crime.

The merit of Dr. White's book consists in its almost mathematical fairness, as well as in the success with which he has availed himself of recently accessible materials. He depicts circumstances and events with a sound perception of their relative importance, and with rare impartiality. He never philosophizes, but arranges his materials with philosophical precision, and as we follow his narrative, we feel the inevitableness of the catastrophe more than the personal guilt of the actors in it, who appear, as they probably

really were, the instruments of destiny rather than the rulers of events. In such destiny there is no blind fatality, but an inexorable law, by which selfishness, ambition, and falsehood, acting at a period when moral and social counter-checks were inefficient, when political ties were loosened, and passions riotous, necessarily led to terrible and calamitous results.

Some historians write as if all the important incidents and characters of an age were the consequences and appendages to a central personage whom they elevate into a fabulous hero. Much of this may be traced in Carlyle, and it abounds in the melodramatic but philosophically worthless efforts of Charles Kingsley. Dr. White is no hero-maker, and he lacks the dramatic power which is necessary to give a strong personal reality to his characters. He does little to stir our moral nature: we do not care very much for Coligny and the other Protestant leaders as he depicts them, nor do we very strongly hate the Guises, or Charles, or Catherine. This result may disappoint many readers; but though we think the story might have been told with equal truth, and with a more stirring appeal to human sympathies, we recognize the value of the level tone which he adopts; and when an author of merit gives us a really good book, we think it ungenerous as well as unfair to criticize it upon the principles of a school to which it was not intended to have any affinity.

To show how Dr. White enables us to appreciate the times in which his scene is laid, we shall advert to a few of the facts he brings forward. He describes France in the middle of the sixteenth century as a monarchy only in name, when, as was usually the case, the king had not enough talent and vigour to maintain his own power. The nobles, he tells us, looked upon the sovereign as little more than the first among peers; and "when Montluc summoned the mutinous nobles of the south to return to their allegiance, and obey the king, they exclaimed, 'What king? We are king. The one you speak of is a baby king; we will give him the rod, and show him how to earn his living like other people.'" The precarious and feeble condition of the crown was a natural result of the general state of the country, which was "divided into numerous provinces, partially independent, under their own governors and parliaments, and with hardly more sympathy between them than there is now between Belgium and Holland. In almost every province you heard a separate dialect; the Normans and the Gascons were mutually unintelligible, and the inhabitant of Brittany had as little in common with the dweller in Languedoc as the

Sussex boor with his fellow-labourer in Picardy." The modern French passion for centralization did not exist even in a rudimentary form; all parties seemed impatient of central control. "The provincial parliaments registered or rejected the king's decree at their pleasure, and the taxes were levied by order of their own estates: self-government in form more than in reality."

Locomotion was difficult and dangerous; large forests sheltered the wild boar, the wolf, and the still more dangerous brigand; and districts separated by a few miles of roadless and trackless country enjoyed no intercourse, so that one might be starving in famine while the other possessed abundance. "It took eight days to carry the news of the Bartholomew massacre to Toulouse, along one of the best roads in France." Under such circumstances there could be little public opinion, though notorious and conspicuous characters might be popular or the reverse. The rural population was in a wretched state; the peasants built their huts in the hollows and valleys, as far as possible removed from the routes of the brigands who composed the armies of those days." Taxation was unequal and oppressive. "Rent was usually paid in kind or in service. If in kind, it was a certain share of the produce, which in Brittany was a twelfth." Money rents were commencing, and feudalism very slowly passing away—so slowly, that at a late date, only "two years before the outbreak of the Revolution, the serfs of twenty-three communities belonging to the Abbey of Luxeul refused to be emancipated, choosing rather to remain as they were, than pay the moderate fine required for their enfranchisement." Wages were low, "the labouring man receiving twelve deniers a day, and a woman six," when a dozen eggs cost eight deniers, a bushel of turnips four deniers, a fowl from two to six sols, a calf five livres, a sheep twenty-four sols, a fat pig three livres, and an ox, three or four years old, ten livres. The common food of the peasantry was unleavened black bread; the usual meat was pork, and as this diet was supposed favourable to leprosy, officials were appointed to look at the pigs' tongues for leprosy spots. "The odious gabelle made salt so dear, that the farmer had often to sell one half of a pig to procure the means of pickling the other half." The clergy possessed enormous wealth, and were for the most part extremely ignorant, so that Montluc, Bishop of Valence, declared, in a sermon preached in 1559, that eight out of ten priests could not read. But if not learned, they were quarrelsome, and required edicts to prevent their using abusive language in the pulpit. Superstition in its most violent form naturally belonged to such a time. To eat

meat on Friday was a deadly sin. Clement Marot narrowly escaped burning for having eaten pork in Lent; and at Angers, in 1539, impenitent Friday flesh-eaters were consigned to the stake, while the penitent were let off with the milder punishment of hanging.

Such a society was in a state of perpetual violence and bloodshed. Even in Paris and other great towns, order was very imperfectly kept, and life was far from secure; and people of all ranks were accustomed to witness and take part in deeds of cruelty and ferocity. Good faith had little existence in public life. Francis I., whom it is the fashion to compliment as a chivalrous sovereign, was neither honest nor veracious. Philip II. habitually employed, and tried to employ, assassination as a tool of statecraft; and if two political factions or families struggled for power, no scruple existed as to the means which they might use. Coarseness and licentiousness were the common characteristics of the men and women of rank and fashion; and when religious differences and difficulties supervened upon such social and political conditions, the confusion became worse confounded, and the fight for existence or for domination more severe.

It may be asked, were the times really so bad? were there no redeeming features, no fine characters, no real learning, no political wisdom, no decency and grace? and the answer must be that such elements existed in far greater proportion than might appear possible under the circumstances, but not in sufficient quantity and force to overcome the mass of evil or direct the progress of events. We are not tracing the happy development of a great country, but considering the circumstances that led to an appalling massacre, and ultimately to a tremendous Revolution, of which the chapters are not yet closed. If the political state of France had been more settled there would not have been the same play for faction, the same tendencies to regal weakness and regal jealousy, and then counsellors like the famous Chancellor L'Hopital—one of the best and most enlightened men of his age—on the Roman Catholic side, might have coalesced or co-operated with men like Coligny and Andelot, on the Protestant side, to secure mutual toleration and freedom of opinion so far as it could have been understood at such a period.

It was unfortunate for the cause of the Reformation in France that Calvin, not Luther, influenced its spirit. The logical dialectic mind and unsympathetic character of the Genevan Reformer did not enable him to adapt his system to an excitable, passionate,

and ignorant population, and the church organization which he established alarmed the ruling powers more than his slavish doctrines of obedience to them effected a conciliation. No monarch of those days could bear the notion of an independent church, and Calvinistic Protestantism did not offer the means of improving and reconstructing what existed; it aimed at the establishment of something new, and for which the bulk of the people were not prepared. Another difficulty which impeded the Protestant cause was the violence of many of its advocates. Their reforming zeal did not always take the shape of argument and exhortation, but was frequently exhibited in sacking monasteries and convents, assailing churches, image breaking, and murdering their opponents, in imitation of the brutalities inflicted by the Romish party upon their predecessors or upon themselves.

When Charles IX. became king he was only ten years old, and Catherine found herself surrounded by dangers and difficulties. She had no real love for France, but much ambition for herself and her children, and she was confronted by the Guises in whom the same qualities of selfishness and ambition predominated. Her first acts showed moderation and a leaning towards the Protestants, and had they been strong enough to have secured her personal power as the reward of her toleration, she would have no doubt acted steadily with them. One of the first proceedings of her regency was to cause the summoning of the States General at Orleans. This assembly consisted of clergy, nobles, and the *Tiers Etat*, or plebeians. The three first met together, and then sat in separate conclaves. The business was opened by the Chancellor L'Hopital, in a speech in which liberal ideas were strangely mixed with narrow views. His political dictum was that the States might petition, but must obey; and when he spoke of religious disputes, he observed that "the sword was of little avail against the understanding," and that "gentleness would make more converts than violence." After which he said it was "foolish to look for peace between two persons of separate creeds." "An Englishman and a Frenchman may live together on good terms, but not two people of different religions who live in the same city." In this unfortunate utterance he was probably guided by the facts he had observed, and did not perceive that a society was possible in which religionists the most opposed in doctrine might agree willingly or unwillingly that law should be supreme. The times, in fact, were too lawless for such an idea to be familiar or easy, and the Frenchman of to-day suffers under the evils and demoralization of despotism because political

parties have remained in the condition which L'Hopital describes as belonging to the religious parties of his time.

After the Three Estates had held their separate meetings, and chosen their "Speakers," they assembled together again on Jan. 1, 1561. Jean Lange, the Speaker of the *Tiers Etat,* denounced "the three ruling passions of the clergy—ignorance, avarice, and wantonness." The Speaker of the nobles complained that the clergy encroached upon the powers of judicial tribunals, and the Speaker of the clergy demanded that proceedings should be taken against all who demanded freedom of worship. In a very different spirit spoke the Abbot of Bois-Aubry, the secretary of the clergy in the preparation of their *cahier.* He discountenanced the employment of the sword or the gibbet, and the assembly of Council. He said the Pope tolerated the Jews, and they were allowed to exercise their religion at Rome and in Avignon, and "could he say that the religion of the Jews, who do not believe in Christ, is better than the religion of those who believe in Him?"

The Estates separated without settling anything, and made the grave political mistake of refusing to take into their hands the power of the purse, on the plea that their instructions did not relate to taxation and supplies. Serious riots between the two religious parties then occurred, and atrocities were committed on both sides, which tended to show L'Hopital's view of the matter was not so far wrong. Catherine again showed a tolerant spirit, liberating imprisoned Protestants, and ordering property to be restored which had been alienated for heresy, and letters patent were issued, commanding the two parties to cease from quarrelling. This was ordered to be read in all churches, and "a Cordelier at Provence introduced it in the following grotesque terms :—'My dear Christian brethren,—I have received instruction to read an edict, ordering cats and mice to live in peace together, and that we in France—that is to say, the heretics and the Catholics—should do the same, such is the king's pleasure. I am sorry for it, and I am grieved to see the new reign begin so unpromisingly.'" Paris, then, instead of being a stronghold of liberal opinions, was quite the reverse, and the Parliament of that city refused to register the edict. It contained very little in favour of the Huguenot party, and was in some points against them.

Dr. White thinks that if Catherine had been a woman of good principles, the current of French history might have been changed at this time; but it needed more than good principles to fight against the Guise party, and the other factions working on the

Popish side, which was powerfully sustained by Philip II., and by most of the great soldiers of the time. Except in Sweden, Germany, and in the Low Countries, no military leader on the Protestant side equalled in skill and tactics the best generals of the opposite party. In the fighting in France which preceded the Massacre of St. Bartholomew, military genius was rarely displayed by the Protestant leaders; and later, when Henry IV. commanded, he threw away again and again his best chances of success, partly from want of skill, and still more from the licentiousness which sent him to his mistresses, when he ought to have exerted all his energies to reap the fruits of the victories he had won. Alexander Farnese, when ill and dying, twice out-generalled him in a manner which marked the difference between the great commander and the brave *sabreur*.

While the two parties were scheming for the gratification of their personal ambition, the States of Pontoise assembled, and L'Hopital, who had thought better of the matter, asked if fellow-citizens of different opinions could not live together in harmony? He opposed edicts against the new religion, and asked if "it were not possible for a man to be a good subject without being a Catholic or even a Christian?" Similar sentiments were uttered by the orator of the *Tiers Etat*. Catherine had sagacity enough to understand the case, and though superstitious, she was not a bigot. She directed Cardinal Ferrara to inform the Pope that the number of persons professing the reformed religion was great, that they were neither Anabaptists nor libertines, that they believed the Apostles' creed, and that many thought they ought not to be cut off from communion with the Church. She also asked what danger could there be in removing images from the churches, doing away with useless forms, and celebrating divine worship in the vulgar tongue? The question of Catherine's sincerity in these expressions has been discussed with different results; but what is meant by sincerity when applied to a woman of her character? That she could be deliberately false, no one doubts; but she was incapable of equally deliberate truth. Probably she meant what she said at this moment, but the self-interest of a low ambition seems to have been her ruling motive, and if sincerity involves the notion of fidelity to any fixed principle, she had none of it. Of course, the Pope would not make the concessions required. An eternal *non possumus* is the condition of the Papacy. A reformed Pope would have been an abolished Pope, then as now.

Passing rapidly over some of the most interesting events, we

came to the Colloquy of Poissy, at which Beza was the chief Protestant spokesman. The chief question at this gathering was, the nature of the Sacrament of the Lord's Supper. Beza said, in a previous conference held in the apartments of the Queen of Navarre, "We hold the bread to be the sacramental body, and we define *sacramentaliter* by maintaining that, though the body be now in heaven and nowhere else, and the signs on earth with us, yet it is as truly given and received by us, through faith in eternal life, as the sign is given naturally by the hands." This explanation caused the Cardinal of Lorraine to turn to the Queen, and exclaim, "Such is my belief, madam; I am satisfied." Charles presided at the Colloquy itself, and read a speech, hoping that it would lead to his subjects living together in peace and unity. The Chancellor L'Hopital followed by a liberal speech, which offended the bigots. Beza's sacramental theory scandalized many of the priests, who called him a "blasphemer," and at one of the private conferences which followed, the bishops rejected the Huguenot doctrine as heretical, and called upon Catherine to compel their submission, or to exterminate them. "For France," they said, "is a country that has never put up with heresy."

The Huguenot pastors unfortunately contributed their full share to the mischief which was brewing. They demanded the exclusion of women from the government of the state, and thus enraged Catherine as John Knox offended Elizabeth, by declaring female rule to be a "monstrous regiment;" and they likewise called for severe measures against "infidels, libertines, and atheists."

About this time there were more than two thousand reformed churches in France, and L'Hopital intimated that "a fourth part of the kingdom was separated from the communion of the Church." The Protestant portion, he said, consisted of "gentlemen, of the principal citizens, and of such members of the poorer sort as have seen the world, and are accustomed to bear arms. They have with them more than three-fourths of the men of letters, and a great proportion of the large and good houses both of the nobility and Third Estate." In fact, though some companions might be found for the Chancellor L'Hopital on the Papal side, the best and most advanced men of France were, as a rule, arranged in the Huguenot ranks, and whatever faults their leaders possessed, they exhibited the Puritan virtues of honesty, sobriety, veracity, and self-sacrifice. They were a noble protest against the vices of the time, and their slaughter and defeat inflicted an irreparable injury upon France. Under a more settled government they would have formed

an influential party growing in strength and gradually moulding the country, but Catherine soon found that a tolerant policy had perils she was not prepared to face. Philip II. was at his pertinacious crafty work in the Escurial, inflicting enormous temporary injury upon the Protestant cause, and unwittingly and insensibly preparing for the ultimate downfall of Spain. Stimulated and helped by Philip, the Popish party in France excited the populace to the most frantic and sanguinary disorder, in which a number of Huguenots were most barbarously destroyed. The Lieutenant-General of Burgundy, a partizan of the Guises, called upon the people "to overpower all who prayed elsewhere than in the churches, and to refuse drink, food, and shelter to the expelled rebels." With such teaching from the pulpit and from political leaders, murders in abundance now followed, and the Protestants were driven to organize for defence. Unluckily they were too late in their arrangements, and their opponents took possession of the king and his mother. A religious civil war was thus commenced; and from all quarters the Protestants rallied round Condé as their chief. The Huguenot army was superior in discipline and in the quality of its components, but their leader was not equal to the emergency, and time was lost in vain negotiation. Fresh atrocities were committed on the Papal side, and in spite of further efforts at negotiation, action began. The royal or Papal forces retook Blois, Tours, Poictiers, Angers, and Bourgs, everywhere committing the most horrible outrages and crimes. Then followed the capture of Rouen, where the Huguenots had unfortunately sacked the cathedral and defaced thirty-six churches, and the Papists glutted themselves with revenge.

Soon after this, Condé lost the battle of Dreux by his impulsive rashness, and the Duke of Guise returned to Paris as the victor and the most popular man of his party. Then came the assassination of Guise by Poltrot, and soon afterwards the so-called "Pacification of Amboise."

This war produced severe distress throughout the country, and the state of political confusion which followed it was worse than what had gone before.

The so-called "Pacification of Amboise" failed to restore peace, because the royal power was insufficient to enforce order, whenever either party thought proper to break it. On the Popish side the most horrible cruelties were perpetrated, and, though in far less number, similar deplorable deeds disgraced the Protestant cause. It is necessary for the truth of history that the hideous tale of

massacre, murder, and mutilation in their most disgusting forms, should be duly told, but it is foreign to our purpose in this review of the times to depict the atrocities of such fiends as Montluc and Des Adrets, or to show precisely how and when the Huguenots too faithfully copied the conduct of their persecutors. On the Papal side the best men had the least influence over the course of events while those who did lead, if not so bad as it has been common to suppose, were still very bad, and immensely inferior in moral character to the chiefs of the Protestant cause. To appreciate the conduct of Catherine and her son, Charles IX., we must bear in mind that after the Amboise failure to restore peace, the country was in the most wretched state of disorder, anarchy, and starvation. It would have puzzled much wiser and much honester heads than theirs to have surmounted the difficulties of the situation, and to have compelled the various parties to obey the law. Philip II., the Pope, and the bulk of the French priests exerted themselves like demons to promote bloodshed and persecution. No statesman of paramount influence on the king's side—which by unlucky accident rather than by design, was the Papal one—seems to have cared a rush for the good of France, or for anything but his own selfish ambition, and though Coligny and his associates were animated with far higher principles of patriotism as well as of morality, the circumstances were not favourable to their success.

In June 1565, when, after making a progress through the south and west of France, Catherine and Charles reached Bayonne, both had become personally acquainted with the fierce hatred with which the populace in many towns regarded the Protestants, and they were constantly called upon to extirpate the heretics. At Bayonne, Catherine and Charles met Isabella of Spain, attended by a magnificent retinue, and in addition to sumptuous pageants and festivities, conferences took place, in which the Spaniards urged an unrelenting crusade against the Huguenots. Isabella, acting by the direction of her husband, Philip II., urged her mother, Catherine, to dismiss L'Hopital, on the ground that he sheltered her bad subjects, and was a terror to the good, and the Duke of Alva replied to Catherine's defence of her Chancellor, that his master desired positively to ascertain whether or not she would put down heresy. At the last conference, the king, the two queens, Anjou, Alva, Don Juan Manrique, Don Francisca Alava, Montpensier, the Cardinals of Bourbon, Guise, and Lorraine, and the Constable Montmorency were present, when the Spaniards advised against civil war as too dangerous, but suggested seizing the Huguenot leaders and cutting off their heads.

The Duke of Alva observed that "ten thousand frogs," by which he meant Huguenots, "were not worth one salmon." Catherine did not fall into this Spanish plot. She wanted to use both parties for her own benefit, and again tried to avoid being made a mere tool of Philip and the Popish leaders. Her son, counselled by his mother, did the same. Efforts were made to induce the Guises to consent to reconciliation with Coligny, whom they accused of complicity with the assassination of the late Duke. The widow and the Cardinal of Lorraine expressed themselves satisfied with Coligny's explanations and disavowals, but the young Duke Henry of Guise wanted to be shut up in a room to fight the Admiral, and admitted that he had plotted his assassination.

Papal massacres, with Huguenot retaliation, continued to disturb the country, and about this time Philip sent 10,000 troops through Burgundy, under Alva, to destroy the Protestants in the Netherlands. Catherine, with real or pretended jealousy of this force, raised a royal army to watch it, and gave the Huguenots cause for believing that it would be used against them. To imprison Condé for life, and put Coligny to death, was said to be part of the scheme. The Protestants took to arms, and, as usual, did not manage their business discreetly. The Constable Montmorency commanded the royalists, who were by far the most numerous, and Condé commanded the weak Protestant force. The Huguenots fought splendidly, but the numbers of their opponents left them no chance of success, and their chief apparent gain in the conflict was in reality a misfortune—the death of the Constable, who was eighty years of age, and represented the more moderate views of his party. The Duke of Anjou, who succeeded Montmorency in command, was too young for a general, even if he had possessed the talent, and the Huguenot side began to succeed. Catherine then opened negotiations, and the extreme distress prevalent in France had begot such a desire for peace, that the Protestant army prematurely melted away. L'Hopital, as usual, honourably expressed himself in favour of toleration, and the Treaty of Lonjumeau was concluded, as another attempt at pacification. Probably again, at this period, if she had possessed sufficient power to keep the bigots in order, Catherine would have sided heartily with Coligny and Condé, not from any high motive, but because she was anxious to keep France independent of Spain from personal ambition, while they wished to do so from patriotic feeling. The Cardinal of Lorraine still exhorted to the extermination of the heretics, and fanatical Papists accused Catherine and Charles of deserving that name. In spite of the

treaty of peace, persecution went on pretty much as before, and the local authorities made regulations intended to vex or injure the Protestant converts. To make matters worse, the Court wanted money, and Catherine obtained a Papal bull, authorizing the alienation of Church property to the extent of a million and a half of francs, on condition of its being spent in extirpating heresy. She cheated the Pope in the appropriation of the funds, and her son made up for it by edicts of persecution, to which he was instigated by Lorraine. The war began again, and Condé was surprised at Jarnac, and had his leg broken by a kick from a horse, in spite of which he heroically endeavoured to cut his way through the enemy; but his horse fell, and he became a prisoner, to be immediately murdered by a follower of the Duke of Anjou.

Henry IV., then Prince of Béarn, and only fifteen (about the age of the Duke of Anjou), was brought by his mother to the Huguenot camp, and hailed as Commander-in-Chief, to replace Condé, though Coligny was the real leader. Coligny won a battle at Roche Abeille, made a mistake in besieging Poitiers, without adequate means, and suffered a severe defeat at Moncontour, in which his jaw was fractured by a pistol shot. After this came more fighting, and then a fresh treaty named after St. Germain's, where it was signed, and which made considerable concessions to the Huguenots.

Historians have questioned the character of this transaction, whether it was intended to maintain peace or only a snare to induce the Protestants to disarm, that they might be caught at a disadvantage. Dr. White decided in favour of the former view, which has the advantage of being in conformity with the general character of Catherine's policy of using the Huguenots as a balance to those opponents of whom she was more afraid.

The character of Charles at this period is enigmatical and contradictory. Probably he had lost all self-control, but not all good qualities, so that at times he behaved with humanity and discretion, and at others like a wild beast. Veracity was a scarce virtue in the courts of his time, and he seems to have had less than usual of what was too often considered an unregal quality. His marriage with Elizabeth, daughter of the German emperor, Maximilian, afforded some hopes of tranquility, as she was expected to exert a beneficial influence over him, but none of the Protestant leaders were present at the rejoicings. If the Papists had been quiet, the St. Germain's treaty might have maintained peace, but there was an incessant clamour for persecution; the queen mother was denounced as Jezebel and the king as Judas, for not gratifying the malignant

wish. The circumstances were favourable to Coligny's acquiring influence at the court, as Charles was evidently afraid of the Guises, who, seeing a prospect of losing their power, determined to get the Admiral out of their way. The Duke of Anjou joined Henry of Guise in hiring Maurevel to assassinate Coligny, but instead of killing him outright, the ruffian only inflicted wounds. This made the position of the Guise faction desperate, and Catherine became their accomplice in order to screen her favourite son. The King was frightened by tales of Huguenot conspiracy, and his mother, having made up her mind to a massacre of Coligny and other Protestant leaders, induced him to give his consent. Thus, the final catastrophe was brought about through Catherine's affection for her young monster of a son, Henry of Anjou, and had he been out of the way, or a little less imbued in guilt, St. Bartholomew's Day might never have acquired its evil renown. The nature of the various incidents do not look like the several portions of an elaborate plot. There were bad circumstances, awkward conditions, and thoroughly unscrupulous agents acting from hour to hour as their selfish interests prompted. The catastrophe in itself was spasmodic rather than premeditated, and far exceeded the intentions of those who brought it about.

Dr. White has produced the best book on this subject. He has left many interesting questions of personal character and motive to be discussed, or cleared up; but he has the great merit of having first distinctly represented the massacre as a portion of a long, and in the main, intelligible chain of events. Viewed in this way it is more instructive and more interesting to the philosophical student than if regarded as a mere outburst of personal guilt.

STORMS AND HURRICANES: THEIR MOTIONS AND CAUSES.

(*Concluded.*)

BY HENRY WHITE, PH.D.

In our last number we described some of the more striking characteristics of hurricanes, and endeavoured to explain certain of their phenomena; for the science of meteorology is still so fragmentary and incomplete, that much still remains for which we cannot account, according to the known laws of physics. One thing, however, seems pretty generally agreed, that hurricanes are cyclones, or revolving winds, moving like the smoke-rings from the bowl of a tobacco-pipe or the muzzle of a cannon. In the latter instance these rings have been observed to have sufficient velocity to disturb the foliage of distant trees. The reality of the gyrating movement of hurricanes is traceable at sea by the aid of numerous and wide-spread observations, which are not easily deciphered by untechnical readers; but there are phenomena noticeable on shore that none can fail to understand. Thus at Barbadoes in 1831 the trees in the northern part of the island lay from N.N.W. to S.S.E., having been prostrated by a northerly wind in the earlier part of the storm; while in the interior and other parts of the island, they lay from south to north, having fallen in the latter portion of the gale. More numerous and striking examples of this rotatory action are found in the tornadoes, which may be called "concentrated hurricanes," or circular storms with a very small radius. In the Brandon Tornado (January 20, 1854), so carefully described by Professor Stoddard, in Silliman's "American Journal," vol. xviii., a fence was thrown down, the western half of which was turned towards the south, and the eastern half towards the north. "If the rails had been removed by hand and laid on opposite sides, the result could not have been more regular." In a forest the trees were prostrated in all directions, but not irregularly. Those to the right of the centre-path of the storm fell in a line exactly parallel with the direction of the path; thence they were prostrated in gradually widening angles, until they lay nearly at right angles with the path, and so on. Trees lay in piles upon each other in quite opposite directions. Some portions of a building destroyed by the storm were carried to the north, some to the south-east, and

others to the west of the foundations. In the Providence Tornado (August 1838), two fences, lying almost parallel with the course of the storm, were thrown down, one northwards and the other southwards. In the Mayfield Tornado (*vide* Silliman's "American Journal," vol. xliii.), the chimney of a house was carried east, and the ridge north-west. Among the piles of trees thrown down in a wood, the bottom tree invariably pointed westward, and the top tree eastward.

It is a pretty well ascertained fact that in tornadoes the air moves spirally upwards, forming an inverted cone with the point downwards. Like a huge funnel, gyrating on its end, a tornado sweeps over the country, sucking up (as it were) the loose objects it encounters, and dropping them far from the places whence they were taken. The same incidents are observed in hurricanes. During a lull in the great Barbadoes hurricane, "the falling of tiles and building materials, which by the last gust had probably been carried to a lofty height, were clearly audible." In the Brandon tornado, a bier was lifted from the graveyard, borne across a road, and deposited in a field. A horse was taken up into the air and carried over a fence; and a cow was blown nearly seventy yards, striking against a tree twelve feet from the ground. In the Mayfield tornado, a boy about eleven years old, while attempting to shut a door, was whirled through a window just burst open, carried a distance of about eighty feet, and dropped down with no more injury than a scratch in the face. At Guadaloupe, during a hurricane (January 26, 1825), a brig was whirled out of the water, and actually blown to pieces in the air (*naufragé dans les airs*). At Santa Lucia in 1780, men and animals were raised from the ground and hurled to a distance of many yards. These things seem incredible, but they are too well authenticated to be doubted. It may be owing to this upward spiral movement that both tornadoes and hurricanes not unfrequently skip over wide tracts, coming down upon the earth, as if by successive leaps, at long distant intervals. But into this matter we cannot enter further than to say that we once witnessed a curious instance of this at Sallèsles, near Narbonne, where a black cloud rushed down from an adjacent mountain (le Pech de Ricaud), and dashing through the village with terribly destructive effect, went bounding and jumping through the plain, leaping over walls and olive plantations, like some atmospheric giant let loose from the cave of Æolus.

The cyclones or hurricanes, as they move forward, do not follow a straight line, but, like huge aerial tops gyrating upon the surface of

the earth, adopt a parabolic course. Their birthplace seems to be not far from the west coast of Africa, on the northern margin of the belt of equatoreal calms. Thence they move in a more or less N.W. path until they approach the coast of North America in 30° N. lat., where they begin to turn, and continue to the N.E., the vortex gradually widening, until they are lost in the wide ocean between Iceland and the British Isles. Some meteorologists suppose their origin to be mechanical. The superior westward velocity of the air (argues Professor Rogers of Glasgow) within the Trade Winds, compared with its sluggish progress on the border of the equatoreal calms, engenders a rotation of the air with a westerly progression of the axis of revolution; precisely as a swift current of water produces small whirlpools wherever it comes in contact with still water, or with a current moving more slowly in the same direction. In the North the gyrating tendency must necessarily be E.N.W.S., or against the sun. In the southern hemisphere (which we have purposely left out of consideration) the direction would be contrariwise. The curious experiments of Count Xavier de Maistre for illustrating the cause of waterspouts, published in the "Bibliothèque Universelle" of Geneva for November, 1832, throw considerable light on the generation of these rotatory motions, and to some extent explain why the movement becomes more rapid than the cause producing it. But if these experiments seem to lead necessarily to the conclusion that the immediate cause of waterspouts, whirlpools, tornadoes, and cyclones is purely mechanical, what is the remote cause, what gives the first impulse? It may be the electric condition of a portion of the atmosphere, or the sudden heating of the air over some insulated spot on the African mainland. The movement once excited, the direction taken by the revolving mass is easily explained. The N.E. trade wind pushes it forward in a westerly direction; the form of the South American continent turns it slightly to the right of the due western path; the West Indian Islands and other parts give it a still greater northern tendency, until it reaches the latitude of Florida, when the upper current from the equator seizes hold of it, and carries it away to the Atlantic, east of Newfoundland. As regards the cause of these terrible atmospheric movements, as well as of those gentler fitful currents we call winds, there is strong ground for believing that they are not occasioned by heat alone. And though it is well known that an immense conflagration, like the burning of a forest, may produce a whirlwind; hurricanes do not occur in seasons when the heat is greatest, or in places where the sun's rays are fiercest. Out of 326 hurricanes recorded by M.

Poey, 35 occurred in July, 88 in August, 77 in September, and 66 in October.

Some very curious instances are recorded of what is called circuit sailing in these vortical storms. Thus one ship, the "Cabot," scudding before the wind, performed nearly half the circuit of the horizon before the gale abated. But the most striking examples occur in the southern hemisphere, where the progressive movement of the hurricanes or typhoons is often very slow:—the "Robin Gray" ran one and a half times round the axis of the storm, until disabled. In like manner the "Argo" made part of the second circuit. The "Charles Heddle" made five complete revolutions in 117 hours, with an average run of 11·7 knots an hour, the whole distance sailed being 1373 miles, while the progression of the hurricane was less than four miles an hour. During this time the ship made a good course of only 354 miles.

In conclusion, it may be well to add a few words as to the rate at which hurricanes or cyclones travel, the width of the surface embraced by them, and the length of their paths. The hurricane of last October took about an hour to travel from Tortola to St. Thomas, a distance of ten miles. Some have advanced at the rate of thirty miles an hour, others at only twelve, while in some of the rotatory storms of the Asiatic and Indian seas the progression has been as slow as three, and even two miles and a half per hour. The "Royal Charter" cyclone moved at an average rate of fourteen miles an hour. It reached Liverpool twelve hours after the wreck of the ship, after which it is named. Here its greatest horizontal motion was fifty-seven miles an hour. Cyclones may cover an immense surface—from 100 to 500 miles in diameter, or even more; if we suppose that the observations recorded in the latter cases refer to the same and not to different storms blowing at the same time. So far as we are at present informed, the Tortola hurricane was probably not more than fifty miles in diameter, while in the case of the "Royal Charter" it was between 300 and 400 miles. It will be understood that the wind acts with diminished violence towards the exterior, and with increased energy towards the interior of the vortex in obedience to the law of equal areas in equal times. The length of the path can only be vaguely estimated, because we do not know in any single instance precisely where it began and where it ended. We only know that it was first observed in one spot, and observed last in another. The hurricane of August, 1830, has been traced from near the Caribbee Islands, and thence to the coast of Florida and along the Carolinas, until it reached the Banks

of Newfoundland, a distance of more than 3,000 miles, which it traversed in six days, at the average rate of about eighteen miles an hour. The hurricane of August, 1827, travelled over 3,000 nautical miles in about eleven days, at the average speed of eleven miles an hour. The September hurricane of 1830 travelled about 1,800 miles, at an average rate of twenty-five miles an hour, and that of September, 1831, passed over the same distance with a velocity of thirty miles an hour. The Cuba hurricane of October, 1844, moved through 12° of latitude with a speed of forty-three miles an hour, its diameter exceeding 1000 miles, so that the storm-path in its total course spread over 2,400,000 square miles. The advance of the gale from lat. 27° to lat. 42° was about 1032 miles in a day. There is some difficulty in estimating the diameter of a hurricane; but in the last instance Mr. Redfield concludes, from data which he has carefully tabulated, that the violent hurricane path of the storm was within a diameter of 500 miles, and as a storm or reefed-topsail gale, 1084 miles. Attempts have been made to calculate the extent of the axial region or area of inactivity in the centre of the hurricane, but the results have come out so variable that no reliance can be placed on them. We only know for certain that this calm region widens as the hurricane advances into higher latitudes.

The vertical height of the hurricane is not conterminous with the height of the atmosphere. During the progress of a cyclone two strata of clouds are observable; the upper moves with the general or local current overlying the storm, and below it is the storm scud flowing nearly in the same direction as the hurricane, but not quite, the scud running, for instance, S.S.W., while the cloud-direction is S.W. In the United States, says Mr. Redfield, the general height of the upper stratus cloud is about one mile, and often below. It must not, however, be concluded that the stratum of revolving wind is of equal height and thickness throughout its extent. Probably it would be found highest near the centre, and sloping gradually away until it coincided with the ordinary current. There are indeed indications to show that violent winds of great horizontal extent are vertically limited to a thin sheet or stratum, like an atmospheric quoit whirling through the air.

It is generally supposed that Franklin was the discoverer of the gyratory theory of hurricanes, but it is not so. It was first suggested by Mr. Richard Budgen in a pamphlet of twenty-eight pages, entitled, "The Passage of the Hurricane from the Sea-side at Bexhill in Sussex, to Newingden Level, 20th May, 1729. London, 1730." Prefixed is a chart describing the course of the storm

from W. to E., with its curves against the sun, increasing or diminishing in diameter, in apparent accordance with the nature of the country over which it passed. That peculiar brightness, the eye of the hurricane as it is called, was plainly observed; "such a strong light in the clouds as far exceeded any of the preceding flashes of lightning." That Mr. Budgen had anticipated later meteorologists is clear from the terms he uses. "The direct velocity of the storm," he says, " is forty-two feet in a second, to which adding forty-two feet for the increase by the vortiginous or spiral motion, makes eighty-five feet, which is the space run through in every second of time near the outward verge of the gyration." He was aware of the calm spot in the centre, though failing to account for it, but adds, "the reason of the trees falling in all kind of directions will readily be understood by a view of the spiral line in the plan." Budgen's theory does not appear to have borne immediate fruit; but it was probably known to Franklin, for his pamphlet was dedicated to Sir Hans Sloane, then president of the Royal Society. Of the author we know only that he was a careful observer, that he lived at Frant, near Tunbridge Wells, and had invented "a new engine to work by the wind."

ASTRONOMICAL NOTES FOR MARCH.

BY W. T. LYNN, B.A., F.R.A.S.
Of the Royal Observatory, Greenwich.

In our notes for this month we shall commence with the positions of the planets.

Mercury will not be well placed for evening observation. Early in the month he sets about half-past six, but being earlier each night, he will soon become invisible to the naked eye through the increasing twilight. At the end of the month he will be approaching his greatest elongation, and will be tolerably conspicuous before sunrise, rising in the last days shortly after five o'clock. He will be in inferior conjunction with the sun at ten o'clock on the morning of the 8th, and will be horned throughout the month.

Venus will be gibbous in form during the whole month. She will be readily observable in the evenings, setting on the first day at eight minutes past nine, and on the last day not until twenty minutes to eleven. On the 27th, a little before two in the afternoon, she will be in conjunction with the Moon, being at the time about $6\frac{1}{2}°$ to the north of that body.

JUPITER will be in conjunction with the Sun on the 10th, and will, of course, not be observable throughout the month.

SATURN will be in view very late in the evenings. Having, however, a considerable southern declination, he will be always low in the heavens. At the beginning of the month his rising will not take place until about a quarter past one in the morning; at the end of it exactly two hours earlier. In our notes for next month we shall offer some remarks upon the position of the rings, and the present state of our knowledge concerning them. On March 13th and 14th the planet will be very near the Moon, being in conjunction with her at eleven o'clock on the morning of the latter day. Saturn's position during this month amongst the stars will be in the constellation Ophiuchus, about halfway between χ and ψ Ophiuchi, two stars of the 5th magnitude.

OCCULTATIONS.—We give our usual table of these phenomena, remarking that the Moon's passage through Taurus on the night of the 1st will occasion some of especial interest, particularly those of θ^1 and θ^2 Tauri, two equally bright stars of the 4-5 magnitude, distant from each other by only about six minutes of arc. σ^1 and σ^2 Tauri are also very close, but the former will escape occultation. The disappearance of 71 Tauri will take place in daylight, but may be observed with a good telescope. Towards midnight the Moon will, in her journey through Taurus, pass a little to the south of Aldebaran.

OCCULTATIONS OF STARS BY THE MOON.

DAY.	NAME OF STAR.	M.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
March 1	71 Tauri	6	5 21	59	6 20	332
„ 1	θ^1 Tauri	4½	6 39	129	7 52	296
„ 1	θ^2 Tauri	4½	6 39	109	7 53	316
„ 1	85 Tauri	6	8 32	93	9 26	353
„ 1	σ^2 Tauri	5½	12 14	63	12 33	23
„ 2	111 Tauri	6	5 25	52	6 30	307
„ 28	48 Tauri	6	7 8	120	8 11	332
„ 28	γ Tauri	4	9 5	147	10 1	304

The angle V. is, as usual, the angular distance on the Moon's disc, counting from the highest apparent point to the right hand, in an inverting telescope, at which the disappearance or reappearance takes place.

THE MOON is in her first quarter at 4h. 49m. on the morning of the 2nd. On the evening of the 1st, therefore, the terminator will pass over the curious formation Hipparchus, nearly in the centre of the Moon. This is a region well deserving of careful examination. Mr. Birt has recently called attention to some remarkable changes of appearance in a small crater on the south-west side of the ridge forming its north-eastern boundary, which he compares to those which would seem to have occurred in Linné. On the evening of the 2nd the well-known walled plain Archimedes, and the grand chain of craters running southerly from the centre of the Moon, near which is the largest, known as Ptolemy, will be regions observable with advantage. Copernicus will be best studied late on the 3rd, and early on the evening of the 4th, when the terminator will intersect, between that object and the Moon's north point, the large plain called the Mare Imbrium. On the 6th the deep crater Kepler, connected with Copernicus by rays, may be well observed. Aristarchus will be on the terminator late that night.

On the 8th at 8h. 22m. the Moon will be full. The night of the 10th the retreating terminator will pass over part of the Mare Crisium, and on the 11th also over the Mare Fœcunditatis. As it is the opposite quarter of the year to that which furnishes the Harvest Moon, our satellite will rapidly cease to be visible in the evening. The conjunction will take place at six o'clock on the morning of the 24th, so that on the evening of the 27th the western edge may again be studied. The interesting Mare Crisium will be traversed by the terminator on that day and the 28th. On the 29th the Mare Tranquillitatis will be in view, and to the south of it will appear the shadow of the ring of the very remarkable and deep crater Theophilus. On the 30th the now famous Mare Serenitatis will be under the terminator, and on that night and the 31st, Hipparchus may again be studied. The Moon will be in the first quarter soon after noon on the 31st (0h. 26m.).

As a reminder to those engaged in star-observing, we will just mention that six o'clock in the evening corresponds, on March 1st, to 4h. 40m. sidereal time, and, on March 31st, to 6h. 39m.

THE SUN.—The announcement made at the meeting of the Royal Astronomical Society last January, respecting the regularity with which observations of solar spots are now carried on simul-

taneously at Kew and at Dessau, leads us to devote a little space to this interesting subject. Two points have lately given rise to controversies in connection with it—the nature of the periodicity of the spots, and the physical character of the spots themselves.

With regard to the former, it is well known that the veteran observer, Schwabe, of Dessau, after thirty years of patient labour in daily registering every spot visible in his telescope, was allowed, in 1857, to have completely established the fact, previously unsuspected, that a period existed in the frequency of spots, which was completed in about ten years. Thus in the years 1828, 1838, and 1848, there were no days on which the Sun's disc was destitute of spots, whereas in the years midway between these, there were a very considerable number of such days, or a minimum number of spots was seen. About the time of Schwabe's discovery, it was remarked by Professor Lamont, of Munich, that the mean diurnal variation of the magnetic declination was also subject to a period in its amount which was likewise completed in about ten years. By the discussion of a large number of observations, he arrived at the conclusion that the actual length was 10·43 years: and he thought it probable that that was also the more exact length of the solar-spot period. Professor Wolf, of Zurich, contended on the other hand that the period of both phenomena was rather longer than this, being about 11·11 years, and Schwabe himself assented to this as probably the more exact number. General Sabine noticed also a decennial period in the frequency and amount of the magnetic disturbances or storms; but this seems to be not so clearly established. The matter is one well deserving of continued attention; and it is one in which, so far as the solar spots are concerned, possessors of even small telescopes may do good service. We believe that the following extract from a letter from Professor Challis of Cambridge, to the writer of these "Notes," will present our readers with the most reliable view of how it at present stands. "I have for a considerable time* regarded the $11\frac{1}{9}$ year period of magnetic declination and variation, as established by the researches of Hansteen, who has very carefully considered this question. I think that with hardly less certainty Wolf has made out the same period for the solar spots . . . The correspondence between the *inequalities* of the intervals between the maxima and minima, which, according to Wolf, is detected on comparing the variation epochs with the solar spot epochs, is a critical point, which, if well made out, almost necessarily indicates a relation

* The letter is dated 1866, April 9.

between the two classes of phenomena. As to the epochs of maxima and minima of magnetic storms, it may very likely require a long course of observations to determine how far they are periodic, and whether the period is the same as for the other magnetic phenomena. From what I noticed when at the Cambridge Observatory, I am disposed to conclude that periodicity of a like kind will be eventually made out."

The other point to which we alluded was the cavernous, or otherwise, nature of the solar spots. Wilson's phenomenon, as it is called, from being described in 1773, as observed in some cases by Professor Wilson, of Glasgow, was, until lately, considered to be decisive for the spots being situated at a lower level than the rest of the surface of the Sun. It consisted in the varying form of the umbra and penumbra of the spots as they proceeded by the Sun's rotation, from one side to the other of his disc. Hence the theory that the body of the Sun's disc is separated from the luminous atmosphere or photosphere by a transparent elastic medium, supporting within it a cloudy stratum, which, reflecting some light from above, forms the penumbra of a spot, whilst the umbra is caused by an opening in this, laying bare the solid body itself, which reflects no light at all.

Now, Kirchhoff, the discoverer of the cause of the dark lines in the solar spectrum, opposes, on chemical principles, this theory. He suggests that the umbra and penumbra of a spot are in fact due to two strata of cloud suspended in the solar atmosphere. He says, indeed,* "I have developed this theory, not from believing that I have established its accuracy, or even being myself convinced of its truth, but merely to show that the phenomena of solar spots are in some measure intelligible without the supposition of a dark and cold body of the Sun, which was, so far as I know, the received opinion amongst astronomers, in spite of its being in contradiction to most clearly-proved physical truths." According to Kirchhoff's theory, the body of the Sun itself is in a state of intense ignition, so that by photosphere he understands the surface of the Sun's body, which he supposes to be surrounded by a cooler atmosphere, in which local diminutions of temperature, give rise, as in our own, to the formation of clouds. And this, he says, appears to be supported by the observations of Father Secchi, whence it appears to result that the polar regions of the sun possess a lower tempera-

* "Astronomische Nachrichten," No. 1634. He here, in a letter to Dr. Spörer, of Anclam (whose labours on solar spots are deserving of all praise) answers some objections which had been brought forward against his theory by M. Faye.

ture than the equatorial zone, occasioning, as on the earth, but with more regularity, an atmospheric current from the poles towards the equator, and a return current at a higher elevation. Thus a region where the two currents mutually bound and destroy each other may be the only one in which clouds are generated of sufficient size and density to appear to us as spots.

If Kirchhoff's theory be correct, the spots are not a *lower*, but at a *higher* elevation than the other visible parts of the Sun's disc or photosphere. It becomes, therefore, exceedingly interesting to know how far Wilson's phenomenon is or is not usually seen during the motion of a solar spot across the disc. Mr. Balfour Stewart and Mr. De La Rue have been carefully examining this question at Kew. It is one which those in possession of moderately good telescopes may help satisfactorily to decide.

MICROSCOPICAL VARIETIES.

A FEW subjects of interest to microscopists may be conveniently grouped together under the above heading, though they have nothing in common but their relation to one favourite instrument of research.

We shall commence by adverting to an alleged discovery of a special vegetable colouring matter called *Xylindeine*, by M. Rommier, who describes it in "Comptes Rendus." It appears that in the Forest of Fontainebleau, and less often in other French forests, dead wood is found which possesses a decided bluish-green tint. The green matter is stated by M. Fordos to be soluble in sulphuric and nitric acids, and to be precipitated without alteration by water. M. Rommier procured a quantity of the green wood, and instead of finding M. Fordos's green matter, called by that gentleman *Xylochlocric acid*, he discovers another substance which dissolves easily in water, giving it a fine bluish-green colour. Acetic acid changes it blue, and most of the other acids precipitate it as green. He says, the "most interesting fact is that, like indigo, it dissolves in alcohol (85° strength) in presence of potash and glucose, and the solution, which is at first brown, becomes green on contact with the air, and soon deposits the colouring matter in a gelatinous form. Silk and wool are easily dyed with it by adding acetic acid to an aqueous or ammoniacal solution of the colouring matter, steeping the thread in it and heating the solution to 80° (C)."

To prepare this *Xylindeine* the wood is dried, powdered, and washed with an alkaline solution containing one per cent. of soda or potash. The liquor is filtered and treated with hydrochloric acid, which gives a voluminous precipitate. The precipitate is composed as follows:—

Carbon	50·23
Hydrogen	5·33
Nitrogen	2·63
Oxygen	40·81
Iron and lime	traces

M. Rommier, who does not seem to know that this sort of green wood is well known to fungologists, finds, on microscopical examination, coloured fibres disposed in various directions, and chaplets of green ovoid sporules. He says it is most commonly found in oaks, and occasionally in birch, the yoke elm, and beech.

The "green oak" of the Tonbridge Wells fancy articles, is a wood affected in this way, and we have in our possession a specimen of birch in the same state. In his "Outlines of British Fungology," p. 67, Mr. Berkeley observes that "when wood is impregnated with the spawn of *Peziza æruginosa* it assumes a beautiful green tint. This is applied to various ornamental uses by the turners of Tunbridge Wells. Few people who admire it when manufactured, are probably aware to what it owes its attraction." Wood in this state made into sections is a very beautiful object for the microscope. It should be viewed in thin sections one transverse and two vertical, one *radial* and the other *tangential*. This last shows the way in which the medullary rays are disposed to great advantage.

To pass to another subject, as the season is coming on, we should recommend a search for specimens of that exquisite larva, *Corethra plumicornis*. It is easily recognized by its glassy transparency, and large conspicuous air-sacs. Professor Rymer Jones, some months back, read an interesting paper on the subject, which will be found in the "Quarterly Journal of Microscopical Science." It remains for him, or some other observer, to trace the real history of the development of the tracheal system, which he states to become suddenly visible.

Some time ago, Professor J. C. Schiödte investigated the mouth-organs of the louse (of which we gave an account in the Intellectual Observer), and demonstrated that it was a suctorial apparatus, and not at all calculated to bite in the manner supposed by writers on the *mortus pediculosus*. The same naturalist has been at

work on the structure of the mouths of the "sucking crustacea," and a translation of his paper will be found in "Annals Nat. Hist." for Jan. 7. We allude to it now merely because it suggests an interesting branch of microscopic study, especially of the mouth-organs of the small parasite crustaceans, many of which are easily obtained.

In investigating small live objects, great advantage will be found in employing the *slide-cells* devised by Mr. Curteis, of Baker's. They can be had of all sizes, to suit elongated larvæ, small worms, or the rounder objects, such as conochilus or cypris. A thin covering-glass rotates over an excavated cell. It should be partially withdrawn from the cell, when the object and water can be readily introduced through a dipping tube. The cover and the slide under it should be kept free from grease, or the water will slip away, instead of remaining in the cell. This is easily done by a little caustic soda. We may mention that the same precaution is necessary in working with Professor Smith's excellent "growing slide," and for want of it some experimenters have been disappointed.

Perhaps the most awkward piece of apparatus attached to a microscope is the common *stage forceps*. Approximating their limbs in an angular fashion, they do not readily hold elastic objects. and cannot be adjusted to any great variety of size. At the request of Mr. Slack, Mr. Ross has constructed an elegant screw object-holder, with sides that approach each other in a parallel direction, like the biting portions of a screw-hammer. The screw being fine, very delicate objects, like crystals of salts, can be firmly held, without risk of injuring their edges. It is found most desirable to mount this object-holder on a small brass frame, which lies on the stage. It has universal motions, and is well adapted to the lieberkuhn, or other illuminating apparatus. It will hold objects from nearly an inch wide, down to fine hairs, and will prove a great convenience to observers.

Microscopy is evidently on the increase, all the principal makers being very busy, and the attendance at the meetings of various societies good. The anniversary meeting of the Royal Microscopical Society, on February 13, disclosed a very flourishing state of its affairs, and the Old Change Microscopical Society gave a splendid entertainment to about thirteen hundred visitors on the 17th at the Cannon Street Railway Hotel. It is impossible not to view with great sympathy the honourable efforts which many of our great firms now make to promote educational movements, or intellectual recreation. A few years ago some commercial blockheads remon-

strated with the late Sir John Lubbock, on the danger his scientific pursuits might do to the credit of his important banking firm. No one now doubts that the present baronet is a good banker because he is known as a good entomologist, and firms like Leaf, Morley, and others, who cannot possibly be accused of indifference to business, are raising the character and social standing of their *employés* by directing their attention in leisure hours to microscopic pursuits.

THE DRAGON TREE OF TENERIFFE.

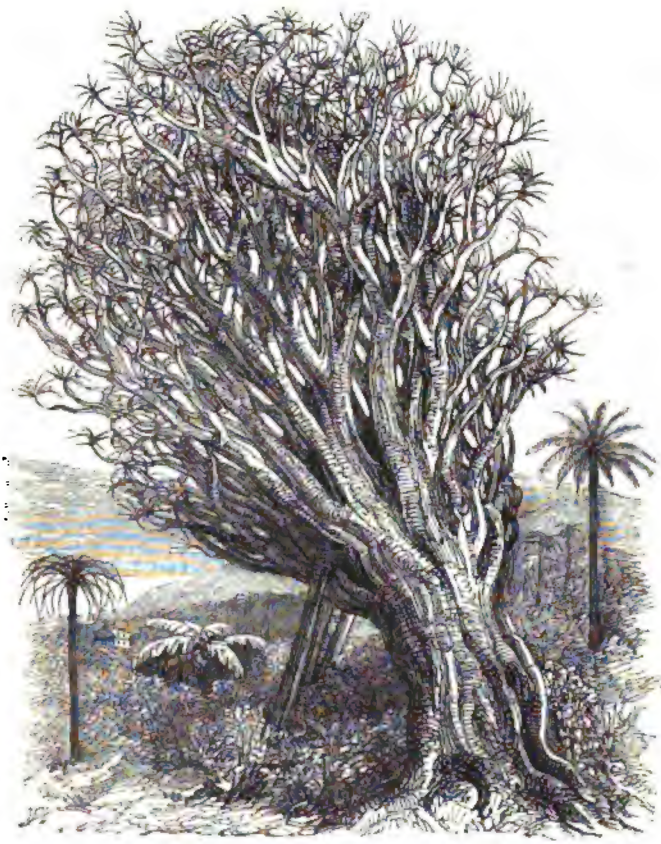
BY JOHN R. JACKSON,

Curator of the Museum, Kew.

One of the oldest and most interesting vestiges of vegetable life has recently been removed from the spot where it has stood for an almost indefinite number of years, making the place of its growth famous from the fact of its presence. We speak of the celebrated Dragon tree (*Dracæna Draco*) which until recently stood at Oratava, Teneriffe. The removal of this time-honoured tree is due to a furious gale which swept across the island last autumn, but of the effects of which botanists have only just become acquainted. This great loss to the botanical world is the more to be regretted, as it seems that little or no care had been taken by the Spaniards to prop, or otherwise support the tree, which, though living and healthy, from the very fact of its age must have required such aid, being computed by some authorities at six thousand years old.

In July, 1819, the tree was severely injured by a great storm, but it survived, and remained until recently one of the wonders of the vegetable kingdom. The *Dracæna Draco* belongs to the natural order *Liliaceæ*, and is, consequently, a near ally to the asparagus. We have it in cultivation in our hothouses in this country, but of course in a young state. At Kew the plant has attained a height of between twenty and thirty feet, entirely unbranched, the stem marked with the scars of fallen leaves. These tall, straight stems, with a tuft of long leaves at the top, have much the appearance of Yuccas, or rather small palms, and give no idea of the habit of the great tree now destroyed. This young state of the plant has been called the first age, or infancy, and in its native country

lasts for a period of twenty-five or thirty years. The second age is that of maturity, or reproduction, and the third age the age of decay. At the second age the leaf scars disappear, and the trunk increases in thickness by the formation of branches; towards the close of this period the plant puts forth its flowers. In the last, or



THE DRAGON TREE OF TENERIFFE.

third age, is produced the irregular, or gnarled appearance which the stems of old Dragon trees exhibit. This appearance is produced by the giving-off of aerial roots, and the formation of glandular excrescences on the hollow part of the interior of the trunk. The leaves, which are three feet or more long, and one to two inches wide, are straight and sword-shaped; the flowers are pale yellow or greenish white, and appear in panicles upon the leafy extremities of the branches. The fruit is a yellowish green berry, becoming

scarlet when ripe. The introduction of the plant into this country is said to date from about 1640. The great interest of the Oratava tree was its immense size and great age. Baron Humboldt says, when he visited Teneriffe, that the tree was included in the garden of M. Franchi. "In 1799, when we climbed the peak of Teneriffe, we found that the enormous vegetable was forty-five feet in circumference a little above the root. Sir George Staunton affirms that at ten feet high its diameter is twelve feet; its height was reckoned at from seventy to seventy-five feet."

Signor Fenzi, of Florence, who visited the tree in the early part of last year, says it was then in excellent health, "its immense crown covered with innumerable panicles of scarlet fruits, and the huge trunk, although completely decayed in the interior, sustained vigorously the spreading mass of fleshy branches and sword-like foliage. On the west side, where the ground was sloping, a solid wall had been built under about one-third of the trunk, while on the other side two or three half-rotten staves propped the more projecting branches. All around the trunk a dense bush of climbers and other plants clothed its expanded base in a very picturesque confusion. I remember now some bignonias, jasmines, heliotropes, abutilons, etc., and also a flourishing almond tree, covered with blossoms, that had grown quite close to the trunk. Its circumference (as far as I was able to measure it, on account of the inequality of the ground) was not inferior to twenty-six mètres (about seventy-eight English feet), while the total height of the tree did not exceed seventy-five feet. And it was remarkable, that through some crevices in the trunk a small Dracæna was to be seen, growing spontaneously in the decayed substance furnished by the parent tree."

If we accept the theories of some authorities, it seems scarcely right to speak of this famous tree in the singular, but rather as a conglomeration of trees, for it appears very possible that the old trunk provides nourishment for the roots of the so-called upper branches, which are thought to be more properly young individual trees; the roots of the upper stems seem to penetrate under the bark of the lower decaying ones, and after the upper stems have branched, their life also leaves them, and they are replaced by young trees of a similar formation on the summit of each of the branches. Thus the upper portion of the old Dragon tree of Orotava would, in fact, be a miniature forest of young plants, deriving their nourishment through the old trunk, and in the downward course of their aerial roots adding new tissues to the trunk, so as to support their

own weight above. It is recorded that the old hollow trunk at Teneriffe has served more than once for a temple for the performance of religious rites—firstly by the Guanches, and later, in 1493, by the Spanish conquerors.

The name of Dragon tree, or Dragon's-blood tree, appears to be derived from the resin which exudes from the trunk, and is known as dragon's-blood, though the dragon's-blood of commerce is chiefly obtained from *Calamus Draco*, an East Indian palm. The Guanches appear to have used the resin of the Dracæna for embalming their dead, for it has been found within their sepulchral caves.

In the Museum at Kew are preserved two relics of the old tree, namely—portions of the branches, one about ten feet high and one foot in diameter.

ACKLAND'S DIVIDING MACHINE.

Mr. Ackland (of Messrs. Horne and Thornthwaite's) is well known as one of the few opticians who dignify their occupation by original talent and scientific culture, and he has recently perfected a method and a machine for dividing instruments according to any scale which admits of calculation. The original purpose of Mr. Ackland's invention was to give a practical answer to a demand made by Mr. Glaisher for a mode of dividing alcohol thermometers, so that the inequality of the degrees should exactly correspond with the inequalities in the ratio of that fluid's expansion, when exposed to a gradually rising temperature. The problem may be better understood if we say that degrees of equal magnitude in a tube of uniform bore do not correspond with the spaces occupied by alcohol as it rises in temperature from a low point of the scale to a high one, or *vice versâ*. In a paper read before the Meteorological Society, Mr. Ackland remarks that "it is well known that the expansion of alcohol by heat is not proportionate to its change of temperature; and we are consequently unable to express its corresponding co-efficient by a simple formula, as for metals and mercury, but must adopt the more complex formula of M. Biot.

$$d = at + bt^2,$$

where a and b are the required co-efficients, and t the temperature."

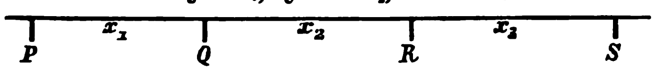
The co-efficient of dilatation for mercury is not the same for all temperatures, but the errors resulting from disregarding this fact amount to very little. Not so with alcohol, for if an alcohol ther-

mometer is marked off correctly at a few positions ten degrees apart, and the interspaces are graduated *equably*, the errors will be found sufficient to vitiate all nice observations. Now it is apparent that any dilatation conforming to a known law of increment, differing from a simple scale, can be represented by degrees, the magnitude of which varies as the law directs; and Mr. Ackland's object was to devise a machine which would reduce the ruling of lines of this description to an exact mechanical operation.

We shall borrow from his paper in the "Proceedings of the Meteorological Society," the following description of the principle involved in his plan:—

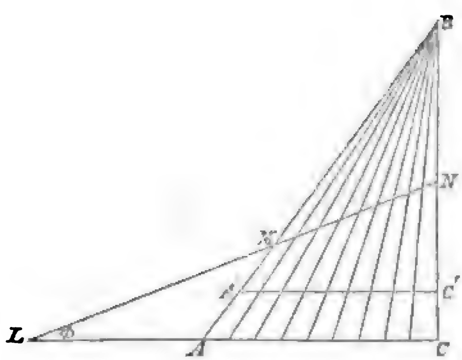
"To illustrate this new method I have invented, let us suppose we have ascertained the fixed points, P, Q, R, S, of a thermometer corresponding to equal differences of temperature. And let

$$P\,Q = x_1,\ Q\,R = x_2,\ R\,S = x_3$$



It is desired to divide the intervening spaces each into ten divisions, so that each division shall occupy its true position.

"To do this, take any right-angled triangle, A B C, and divide the side A C into ten equal parts by straight lines drawn from B.



"Then, if a straight line, as A′ C′, be drawn parallel to A C, it will be divided into ten equal parts; but if it be drawn not parallel to A C, it will be divided into ten unequal parts."

It is evident from inspection of the diagram, that in proportion as a moveable arm, L N, is raised above the base, A C, the spaces marked off upon the group of radiating lines will differ from each other in magnitude, and that by setting this arm to any particular angle a series of interspaces will be obtained, diminishing in any definite proportion that may be required.

Mr. Ackland's machine is so constructed, that by setting it in this way it will rule off upon glass or other material a scale with any regular degree of increment required. If for any particular purpose an irregular scale were wanted, it would prove equally efficient, provided the positions of the required irregularities were known beforehand. It could, for example, rule a regular scale, and intercalate lines, at any points required.

To facilitate the use of this machine, Mr. Ackland has devised an ingenious mechanical computer; so that if it is determined to rule degrees increasing or decreasing in any known ratio, he can save the trouble of computation, and set his engine to do what is required.

It is evident that in addition to a remarkably perfect graduation of thermometers, hydrometers, etc., this machine may be employed for a variety of scientific work; and we have no doubt, as it becomes known, its ingenious inventor will have numerous applications for its use. Some alcohol thermometers graduated in this way have been highly commended by Mr. Glaisher after careful trials.

PROGRESS OF INVENTION.

Galvanic Battery with Picric Acid.—The nitrous fumes evolved when a Bunsen battery is at work, render its employment in confined situations very objectionable. If, however, a cell be filled with an aqueous solution of picric acid instead of with nitric acid, and if, instead of dilute sulphuric acid, a solution of common salt be used, a powerful action will be obtained. The addition of a few drops of sulphuric acid to the picric acid solution will greatly increase the strength of the current. This battery will be found very useful for telegraph purposes, and in all cases where the evolutions of nitrous fumes may prove objectionable.

Separation of Stearic and Margaric from Oleic Acid. — Bourgougnon has made an emulsion with fat and an aqueous solution of ammonia, by which the oleic acid is easily and completely separated, so that nothing remains but a mixture of stearic and margaric acids to be converted into soap.

Ornamental Bookbinding.—Fish-scales are largely used in the manufacture of artificial pearls. A new application of them has lately been made by Mr. A. Parkes, of Birmingham. He proposes to ornament book covers by fixing them firmly to embossed paper, linen, or other suitable material. He first embosses his material with undulations or patterns,

and then coats it with a varnish, consisting of dissolved pyroxylin, or parkesine and fish-scales. The fish-scales sink, for the most part, to the bottom of the hollows of the embossed surface, the solvent evaporates, and they become fixed, and the light playing on them produces a very pleasing effect, it being strongly reflected by the scales where it strikes at a suitable angle. The fabric or paper, after the application of the scales, can be embossed as well as before. Other materials beside parkesine may be used for the varnish, such as shellac, glue, or gelatine. Mr. Parkes also prepares a varnish with pyroxylin and aniline dye, which, when crystallized, has a metallic lustre, and this is applied to the embossed paper; here also the paper can be embossed, after the application of the varnish. In a similar manner varnish containing bronze powder can be applied to paper before or after embossing. The spreading is effected by a roller.

PURIFICATION OF PARAFFINE.—Impure solid paraffine may be purified by first powdering it, then mixing with it common naphtha, and afterwards subjecting it to considerable pressure. By repeating this operation several times the paraffine may be almost entirely freed from the heavy hydro-carbon oils with which it is contaminated in its impure state.

INKSTANDS.—IMPROVEMENTS IN FOUNTAIN INKSTANDS.—To prevent the ink running over the dipping-pan an independent air passage is made in the body of the inkstand, by which a constant level of the liquid is obtained, and this is produced by the action of a column of air, which causes a pressure upon the passage of the liquid, and thus prevents it from overflowing the dipping-cup. The construction is very simple: the tube is attached to the inner wall of the ink-chamber, in which a hole leading outwards is made, so as to admit the air into the tube, and through this hole, the ink can be poured to fill the inkstand. The lower end of the air passage, which is open, descends an inch or thereabouts below the level of the dipping-cup, between it and the reservoir.

MACHINE FOR HATCHING EGGS.—Some years ago an incubator was made which hatched eggs by application of heat from above. This certainly seems to be the most natural way, as the heat from the hen's body strikes from above downwards. A new hatching machine has been invented and patented by T. Horrex, which acts on this principle, although in the application it is different from the method before alluded to. It consists of a flat case of metal, or other material, to hold water or any other fluid which may be thought desirable; this case rests on a frame or box, and under the lower end of the metal case, which is rounded for the purpose, a small lamp or gas-burner is placed. Mr. Horrex prefers to use a small tray of tin partly filled with oil, upon which is floated a wick; under the other or higher end of the flat case, holding the water, is placed a box or tray of a wedge-like form, for reception of the eggs. The box or tray being of this shape admits of the eggs being placed near to or at a distance from the source of heat, by simply pushing the box or tray

forward, or by withdrawing it just as one would do with an ordinary wedge, and so the heat may be regulated at pleasure. Around the top of the box tubing or list can be fastened to prevent the escape of heat. The box is partly filled with sand and such materials as will assimilate it to a hen's nest. The merit of this invention seems to consist in the easy manner of regulating the heat.

Galvanic Batteries.—The object of the following invention is to make batteries more constant, to work for a longer time, to do away with the formation of dangerous fumes and polarization on the elements or in the porous cells. To accomplish this Mr. C. Bowlay makes use of the following arrangement. A porous vessel is divided by means of one or more porous partition plates, or diaphragms, into two or more separate cells, each containing its own electrolyte, or galvanic element (zinc, copper, carbon, etc.), and the exciting salt or mixture, in the dry, or slightly moistened state, and which can attract moisture from a liquid contained in an outer vessel, in which the porous cells are placed. Thus, for example, in case the porous vessel be divided into two cells, one may receive a zinc plate, or other positive element, and the other a negative element, and the cell be filled with a mixture of flowers of sulphur and chloride of sodium, whereas the other cell is to contain the negative element (copper, carbon, etc.), and be filled with a mixture of sulphate of copper, or nitrate of potash; the porous vessel is then placed in the outer vessel, and the space between them is filled with a mixture of crystals of sulphate of copper, which space may, if wished, receive in suitable opposition, a zinc and a copper plate for forming a second galvanic couple, to be used either alone, or in combination with that of the porous vessel, or be entirely left out of action. The outer vessel and the porous cells are then closed with a suitable cement, through which pass the tongues, or electrodes, for establishing metallic connection, also one or two small tubulated funnels, for allowing the proper quantity of water to be poured into the outer vessel for the solution of the sulphate of copper contained in it. The salts, or mixtures, used in the porous cells, should freely attract water, in order always to keep them in the proper moistened state required for the production of the galvanic current. For this purpose, glycerine, treacle, or other water-attracting substances, may be made use of.

LITERARY NOTICES.

A Treatise on Astronomy. By Elias Loomis, LL.D., Professor of Natural Philosophy and Astronomy in Yale College. Author of an Introduction to Practical Astronomy, and a Series of Mathematics for Schools and Colleges. (New York: Harper Bros.; London: Trübner and Co.)—This work will be a valuable and welcome addition to our

stock of first-class educational books. Its plan is somewhat like that of the well-known "Outlines" of Sir J. Herschel, and in a series of short sections it explains the leading parts of astronomical science. It begins with the phenomena of diurnal motion, the figure and dimensions of the earth, and similar matters, which are lucidly explained with the help of judicious diagrams. In a second chapter, we find brief but comprehensive descriptions of the principal astronomical instruments. The third chapter carries us into the laws of atmospheric refraction, twilight, etc.; after which, in the fourth chapter, the "sun's apparent motion, change of seasons, different sorts of time, the calendar, and other matters come in review. Succeeding chapters deal with various astronomical phenomena, the constitution of the sun, moon, planets, etc. The explanations are very cleverly arranged, so as to require only a very small quantity of mathematics to follow them. Professor Loomis states in his preface, that his object has been to furnish "a text-book for the instruction of college classes in the first principles of astronomy;" and that he has dwelt more fully than is customary "upon various physical phenomena," such as the constitution of the sun, the condition of the moon's surface, eclipses, tides, and so forth. We think the book not only adapted to school and college classes, but to private study; and it will be found very convenient for reference, and would have been still more so if, in addition to a good "table of contents," there had been a proper index. The diagram illustrations are numerous and good, but the plates are not worthy of the work, those of the moon being especially bad. As the work is dated 1867, we think Professor Loomis might have given the recent determinations of the sun's distance, and have taken notice of Mr. Huggins's important spectroscopic researches into the constitution of nebulæ. While regretting these omissions and defects, we strongly recommend attention to the book, which will be found one of the best that has been produced.

A MANUAL OF INORGANIC CHEMISTRY. Arranged to facilitate the Experimental Demonstration of the Facts and Principles of the Science. By Charles W. Eliot, Professor of Analytical Chemistry and Metallurgy, and Frank H. Storer, Professor of General and Industrial Chemistry in the Massachusetts Institute of Technology. Second edition, revised. (Van Voorst.)—It is unfortunate for compilers of chemical text-books that the science of which they treat is in a transition state, and the principal schools in which it is taught are not agreed upon certain important theoretical questions. In England, Professor Williamson and other great authorities have done much to promote the reception of the new views, and we may safely assume that they will prevail. They are probably more correct than the older ones, and the method of teaching founded upon them possesses a very striking superiority.

The authors of the book before us adopt a medium course; they give the atomic weights required by the followers of Gerhardt, but do not

found their course of instruction upon the principles which the new system involves. This will make their book acceptable or not, in proportion to the importance attached to the new system. They are right in pointing out that "the existence of atoms is itself an hypothesis, and not a probable one;" and in cautioning students to be cautious in accepting all doctrines founded upon such a theory, we are afraid they are also quite right in saying that "the great majority of chemists devoted to the application of chemistry in meteorology, metallurgy, dyeing, printing, and the manufacture of chemicals, remain completely indifferent to discussions of chemical theories;" but these "practical" folks, as they like to be called, are often the most impracticable—they work by rule of thumb, and have no intelligent mode of guiding themselves in new inquiries. The new system of teaching chemistry brings theory into its due prominence, and a student who goes through a good course—say at University College—will be much better fitted for the practical employment of the science than if he had been taught on the old mode.

With the exception of the chapter on Ozone, which is founded upon the theories of Schönbein that have been overthrown by experiment, we think Messrs. Eliot and Storer have produced a useful and clever work, well filled with substantial information.

NOTES AND MEMORANDA.

Scientific Soirees.—On the 15th Feb., the President of the Geological Society, Mr. Warrington Smyth, and Mrs. Warrington Smyth, gave an elegant reception at Willis's Rooms to Fellows of the Society and other scientific celebrities, with their wives and daughters. Some remarkably fine paintings of Alpine scenery and other interesting and appropriate objects were exhibited. Mr. Warrington Smyth is, we believe, the first president who has given an entertainment of this description, and it was gratifying to note, from the distinguished character of his visitors, and the universal satisfacti on expressed, how highly his hospitable efforts were appreciated. On the 17th Feb., the Old Change Microscopical Society, under the presidency of Charles Leaf, Esq., F.R.M.S., gave a highly successful soirée in two fine suites of rooms, including the great hall of the Cannon Street Railway Hotel. In addition to an important display of microscopes, some fine collections of art objects, minerals, etc., were exhibited. About 1300 visitors were present.

Mars' Rotation-Period.—The correction of Mr. Proctor's estimate of Mars' Rotation-period was not quite correctly given in the February number of The Student. Mr. Proctor's first estimate was 24h. 37m. 22·745s. (not 27·745s.); the corrected estimate is 24h. 37m. 22·73s., or 0·015s. less. Mädler's estimate was 1·07s. greater, Kaiser's 0·13s. less than Mr. Proctor's corrected estimate.

Permeability of Cast-Iron Stoves.—General Morin having requested MM. St. Claire Deville and Toost to examine the air circulating round cast-iron stoves strongly heated, they report that when the iron is at a dead or a bright red heat, the

gases of combustion are able to permeate it. They observe that the experiments of Mr. Graham has shown that a red-heat iron absorbs 4·15 times its volume of carbonic oxide when exposed to an atmosphere of that gas, and they find that carbonic oxide is absorbed by the interior surface of the stove, and given out by its exterior surface, so as to produce a sense of discomfort to those who inhale it.

GRAPTOLITES.—In "Annals Nat. Hist.," Dr. H. A. Nicholson argues in favour of placing the graptolites amongst the Hydrozoa. He considers that "they more or less resemble hydroid polyps, but are widely separated by their free hydrosoma. On the other hand, they approximate to the oceanic Hydrozoa in the fact that they were free floating organisms, and in the possession, by some forms, of an organ resembling a float."

CHANGES IN POLAR TEMPERATURE.—Professor O. Heer, in discussing the probable causes of the warmer temperature which must have formerly existed in polar regions, as indicated by the recently-discovered miocene fossil flora, is disposed to assign an important influence to the variations in the temperature of different portions of space which Poisson conjectured to exist. He conceives the sun to carry his planets through regions varying sufficiently in temperature to give rise to secular seasons of enormous length. There may be something in the idea, but we are yet without any proof that important variations in the temperature of space really exist.

HEATING POWER OF THE MOON.—The "Monthly Notices" contain a paper by Mr. J. Park Harrison, M.A., under the title of "Inductive Proof of the Moon's Insolation," in which he observes, that "the heat acquired by the moon and radiated to the earth, is entirely dark heat, and this, as Prof. Tyndall has pointed out, would be almost wholly absorbed by our atmospheric vapour. It would consequently tend to raise the temperature of the air above the clouds, and cause increased evaporation from their surface. Cloud would therefore be diminished in density, and raised to a higher elevation, and under favourable circumstances would be dispersed; in either of which events a sensible fall would necessarily be caused in the temperature of the air near the ground, owing to increased radiation of terrestrial heat to the sky. And precisely opposite results would occur at the period of minimum heat in the moon." He states that "the observations at Oxford, Berlin, and Greenwich show conclusively that the temperature of the air near the ground was very sensibly affected, the maximum mean temperature occurring on the average at each of the three stations upon the sixth and seventh day of the lunation, when the moon's crust, turned towards the earth, is coldest, and the minimum mean temperature when the same crust has been exposed for several days to intense radiation from the sun." An exception to this rule of action occurs through the formation of fresh cloud a day or two before the third quarter. When this periodic cloud is dispersed, a rapid fall in the temperature occurs. "No rise or fall of any amount occurs at new or full moon, though a tendency towards change seems clearly indicated shortly before full moon. The difference between the maximum and minimum results is 2°·3 F." Thus it seems ascertained that there is some truth in the long-cherished popular belief that the moon does exert an influence on the weather, though not to the extent supposed. There may, however, still be methods of action not yet ascertained.

VIOLET PLANTAIN-EATER.
Musophaga violacea.

WHITE-CRESTED TURACU.
Turacus albocristatus.

THE STUDENT,

AND

INTELLECTUAL OBSERVER.

APRIL, 1868.

TURACINE, A NEW ANIMAL PIGMENT CONTAINING COPPER.

BY PROFESSOR CHURCH, M.A.,

Royal Agricultural College.

(*With a Coloured Plate.**)

Historical Notice.—All the colours which the feathers of birds display, are due either to what we may call the "optical" character of the surfaces of the web, or to the presence in it of definite colouring matters. These colouring matters have been as yet but very imperfectly studied. In two or three instances only have they been actually separated from the feathers containing them, while in no case have they been accurately examined from a chemical point of view. So far as I can learn, we have no exact information as to the amount and the chemical constitution, deportment, and reactions of those substances which M. Bogdanow, some ten years ago, succeeded in extracting from the red feathers of *Calurus auriceps* and *Catinga cœrulea.* Without further retrospect, however, I will now give an outline of my own experiments in this direction, experiments which have led to some very interesting though unexpected results. First of all, then, as to the immediate origin of the present inquiry.

About two years ago, my friend Mr. W. B. Tegetmeier pointed out to me a singular property of the red feathers of the bird

* The plate represents *Turacus albocristatus* and *Musophaga violacea*, two of the birds from which the peculiar colouring matter has been obtained.

called the "plantain-eater." These feathers yield up their colouring matter to pure water, a beautiful rose-coloured solution being formed. Mr. Tegetmeier's attention had been drawn to this fact, and he at once saw that it was worthy of fuller investigation than it had already received. On further inqnuiry, I find that Mr. Ward, of Wigmore Street, had noticed the evanescence and solubility of the red tint in question many years ago, and that other observers within the last few years had even succeeded in staining pieces of paper with the coloured solution which these red feathers yield. When I commenced, in 1866, my experiments on this subject, I was not aware how far the investigation had been then carried, and how well ascertained was the interesting fact concerning the solubility of the red pigment in simple water. In order that it may be seen what was then the position of the inquiry, I will cite a few extracts from letters which have been placed at my disposal. These letters were written by Dr. Benjamin Hinde, principal Medical Officer on the Military Staff at Bathurst, on the Gambia, and I am indebted to the courtesy of Mr. Hugh Owen, of the Finance Department of the Great Western Railway, for the loan of them, and for other details concerning the present investigation. Here is a paragraph from one of Dr Hinde's letters, dated Bathurst, May, 1865. "I enclose a piece of paper stained with the crimson from the feather of the *Corythaix* (the *Musophaga violacea*, which is much more common here); all this colour came from the inch of feather enclosed. I also send some feathers partly washed: one of them especially, I have washed to a pale pink at the base, leaving the colour much darker at the tip. The moment soap touches them the colour runs, but I find it difficult to get it out in pure water. Nevertheless, the birds I sent home washed themselves nearly white in the water left for them to drink!" In a subsequent letter, Dr. Hinde gives some details concerning the different species of plantain-eaters, and also says with reference to the feathers he had previously sent to England—"all the feathers sent were from the same bird and grew in this house!" This fact negatives any idea of an artificial dye being present in the feathers, and is further referred to in the following memoranda, by Mr. Hugh Owen. "A pair of violet plantain-eaters from the Gold Coast were sent over to a friend in Ireland by Dr. Hinde. The birds arrived in excellent condition, and were speedily provided with ample space and all appliances for cleanliness. For a while the splendid plumage of the strangers, the brilliant crimson patch on the deep violet, nay, almost black, of the wing excited continual admiration. After a day or two the

crimson faded—in a few more the colour changed to a pale and dirty grey.

"The disappointed owner wrote an account of this change to Bathurst, concluding, of course, that the wily natives had imposed on Dr. H. by selling him a pair of painted birds; this was, however, impossible, there was no mistaking the peculiar and shield-shaped bill, or the legs of the Musophaga. Whatever change had taken place, the birds were genuine Touracos.

"Without delay another bird was procured, so young as to be only partly fledged, the wings only in the pin feathers. As soon as these were sufficiently grown, the experiment was tried, and the colours found to be inconstant and capable of extraction."

The data already given, and others with which I have been furnished, incontestibly prove the presence in the plantain-eater of a red pigment, soluble in water, and still more easily soluble in soap. I will now give my own results as to the isolation and chemical characters of this red animal pigment.

Sources of Turacine.—First of all, as to the bird, or I should say birds, from which I have succeeded in extracting this colouring matter. They are of several species, and generally go under the designation of plantain-eaters, the native African name for them being represented by the word Touraco; while the Dutch, I believe, speak of one of the species as the Cape Louri * (not Lory). These birds are entirely African. They belong to the Order Scansores, and the Family Cuculinæ. The Musophagides constitute the first section of this family, and to this section belong three genera, namely Turacus, Musophaga, and Shizorhis. From two species of Turacus, and one of Musophaga, I have procured the new red pigment. Here is a list, with localities, of these three species:—

Turacus albocristatus, Cape.
T. porphyreolophus, Natal.
Musophaga violacea, Gold Coast.

The plumage of these birds does not present any great general brilliancy. The dusky tints of most of the large feathers of the tail and the smaller feathers of the wings have usually a more or less decided green or violet metallic reflexion, while the wing coverts in some species are greenish, and of that variety of colouration which has been termed enamelled. The red pigment occurs in the primary and secondary pinion feathers, from twelve to fifteen of which have

* "Zoology," by J. Van der Hoeven; English edition of 1858; vol. ii., page 450.

either a crimson blotch upon them, or are almost wholly coloured. I propose the name Turacine for the crimson pigment which the Turacus contains. In order to extract this pigment the plan finally adopted was as follows :—

Preparation of Turacine.—The barbs constituting the red part of the web are stripped from the shaft of the feathers, placed in a beaker, and washed with ether and then with alcohol. This treatment removes the grease and adherent dirt very effectually. When the red barbs thus washed have been dried between folds of filter paper they are placed in a cold, very dilute, solution of caustic soda—a solution containing one part of alkali in five thousand of distilled water being quite strong enough. Ammonia, potash, or the carbonated alkalis may be used in lieu of caustic soda. The mass is stirred at intervals for fifteen minutes or thereabouts: the red solution is poured off and pure water added: by successive treatments with fresh portions of dilute alkali and pure water, the whole of the crimson pigment is obtained in solution, and the residual barbs are left white or pinky grey. All the coloured liquors having been mixed, they are poured in a slender stream with constant stirring into dilute hydrochloric acid made by mixing one part of the commercial acid with nine parts of water. When the red precipitate of the pigment thus rendered insoluble has settled, the supernatant liquid is decanted off and the red matter thrown upon a wetted filter and washed with water. The liquid comes through quite colourless until there is no longer any trace of acid left in the pigment on the filter. When this occurs the residue on the filter is washed with water containing a few drops of acetic acid to the pint of water, and then syringed out of the filter into an evaporating basin, and dried at a gentle heat. The dry pigment is next to be washed with a mixture of alcohol and ether and once more dried. It is now perfectly pure and yet unchanged, so far as I have examined it.

Properties of Turacine.—The following are the chief characteristics of the new pigment, turacine. Prepared as before described, it occurs in scales having a deep violet purple colour by reflected light, and showing a crimson tint when seen in small fragments by transmitted light. It has not yet been obtained in a crystalline form. It is slightly soluble in pure water, giving a rose-red liquid. The presence of acids and salts renders water incapable of dissolving it. It is not soluble in pure alcohol or ether. In alkaline liquids of all kinds it immediately dissolves, forming solutions which show a bluer tint than that of the original pigment. Very strong solutions of the caustic alkalies dissolve the pigment, but at the same

time it suffers a partial decomposition, evidenced by an odour, resembling that of certain organic bases which it then evolves. Fuming nitric acid dissolves it with a deep brown tint, destroying it; in oil of vitriol it is soluble with partial alteration. Turacine seems to have slightly acid properties.

Turacine by long exposure to air and moisture, or by long continued ebullition with water acquires a colour closely resembling that of chlorophyll.

Spectrum of Turacine.—A few of the red barbs of *Turacus albocristatus* were placed under the micro-spectroscope, and two black bands were at once perceived in the space between the lines D and *b* of the solar spectrum. These bands correspond very closely in position and breadth with those of Stokes's red cruorine, but I am not prepared to affirm that they are identical. When an alkaline solution of turacine is similarly examined, the bands seem shifted further from D, while the blue region of the spectrum is less shaded than it is with the original red barbs, or with coagulated turacine precipitated from its alkaline solution by an acid. When the alkaline solution of turacine is weak, the band near *b* is very weak, but when a strong solution is employed, both bands become equally dark, and finally almost coalesce, nearly obliterating the space in the green between them. No definite results have attended my attempt to produce in turacine, by ferrous or stannous salts, a similar reduction to that obtained in the case of red cruorine by the same means. I fancied, however, that the band near *b* became less distinct after this treatment of turacine. Coagulated turacine in water, and the web of the red feathers, present exactly the appearance of diluted arterial blood to the eye.

Composition of Turacine.—Turacine may be heated to 100° C. without change, but at a much higher temperature its surface-colour alters, becoming bluish, and then a dull green. Afterwards it shows some signs of fusion, giving off a violet vapour closely resembling than of iodine, and finally burns away, leaving a greyish black ash. The volatile constituents of turacine are carbon, hydrogen, nitrogen, and oxygen, in what proportions I have not yet ascertained, but I have submitted the ash or non-volatile constituents of the new pigment to a careful examination.

The close resemblance of turacine to cruorine induced me to test at once, in the ash of the new pigment, for iron, the characteristic metallic constituent of the colouring matter of the blood. The ash was dissolved in nitric acid, excess of sodic acetate added, and then potassic ferrocyanide. To my astonishment, instead of the deep blue

of the ferric ferrocyanide, the rich purple brown precipitate of the cupric ferrocyanide was at once seen. Not only was copper present, but there was so much of it that it could be detected by its spectrum in a few of the red barbs of the original feathers, by burning them on a platinum wire, moistening them with strong hydrochloric acid, and then placing the ash in the flame of a Bunsen burner.

This detection of copper in the colouring matter was so extraordinary, that I determined to sift the matter thoroughly. My first thought was that a preservative solution containing cupric sulphate had been employed in dressing the skin of the birds; but I soon found this notion untenable, for there is no copper in any part of the bird save in the red feathers, and in these feathers themselves the presence of copper is strictly confined to the red barbs. Even barbs that are partly red and partly black contain no copper in their black parts, and abundance in those which are red. Moreover, as acids do not wash out the copper from the feathers, and the most severe chemical treatment short of actual destruction of the pigment itself does not remove it from the prepared and pure turacine, it is evident that this metal, copper, is an integral constituent of the substance under investigation. To give an idea of the intimate union between the copper and the other constituent elements of the colouring matter, I may mention that I once dissolved some turacine in oil of vitriol, diluted with half its bulk of water, precipitated the turacine again by sodic acetate, and found that there had been no loss of copper by solution in the strong acid.

I have examined with care the different parts of eighty-seven red feathers of *Turacus albocristatus*. From the red barbs of these some of the colour which I examined was prepared, but their shafts were submitted to dissection. The clear horny parts, or quills proper, at the base of each feather, were cut off, and separately incinerated: so also were the upper parts or shafts of the eighty-seven feathers, and in like manner the membranes found in the quills. There was no copper in the ash of the eighty-seven quills, and none in that of the membranes; but a very minute trace was found in that of the shafts.

There is, therefore, no possibility of any mistake having occurred as to the copper present in the red parts of the feathers of the Touracos. It cannot have been introduced in any preservative solution, for it would then be found in the black parts of the web as well as in the red; it cannot be an artificial dye, for birds bred in

captivity acquire the cupreous pigment naturally; it cannot be an accidental and unnecessary constituent of the red colouring matter, for not only is it impossible to remove it from the colour, but the proportion of copper present in the turacine obtained from different individual birds remain constant. I will now state what this proportion is.

In my first analysis I employed acetic acid to precipitate the turacine from the alkaline extract of the feathers. Now, on burning some turacine thus prepared, I found that it left a very considerable amount of ash, nearly twice as much as in subsequent experiments where hydrochloric acid had been used as the precipitant of the pigment. Some calcic and magnesic phosphates had obstinately adhered to the precipitated turacine, and were found in the ash. The same salts accompany the colouring matter of blood with similar tenacity. But it was soon found that the new pigment might be obtained in such a state of purity as to leave no other ash when burnt than nearly pure cupric oxide, oxide of copper! the seven per cent. of calcic phosphate, and the traces of other substances having been previously removed by the action of dilute hydrochloric acid, without any change in the turacine itself. The results of very careful determinations of the amount of copper in two different specimens of pure turacine were quite accordant, one analysis (the details of which it is not necessary to give here) affording me 7·20 parts of black oxide of copper in 100 parts of turacine; the other yielding 7·38 parts. These proportions correspond respectively to 5·75 and 5·89 parts of metallic copper in 100 of the red pigment. I am inclined to think that this amount is really rather below the true per centage, but this point is now being further investigated.

Affinities of Turacine.—Although in its colour, in its absorption spectrum, and in some of its other characters, turacine corresponds very closely with the scarlet cruorine of blood, yet it contains no iron, or the merest trace of that metal. Iron, however, exists to the extent of between six and seven per cent. in hæmatine, the chief derived colouring matter obtained from blood, and is doubtless an essential constituent of the original scarlet cruorine; but I venture to hazard the conjecture, that in turacine copper replaces the iron of cruorine, and that this new pigment is, after all, a *copper cruorine.* Still it does not occur in corpuscles, but homogeneously distributed in the barbs, barbules, and crochets of the red feathers of the birds in which I have found it. It would seem to characterize the closely-allied genera Musophaga and Turacus. It is most abundant at the pairing season, and the bridal plumage of a

Turacus albocristatus generally yields about three grains of the pigment.

Turacine is the first animal or vegetable pigment, containing copper as an essential element, which has been hitherto isolated; yet traces of copper have been repeatedly found both in animals and plants. It was detected by Harless in the blood of certain Ascidia and Cephalopoda. It occurs in *Limulus cyclops, Cancer pagurus, Acanthias zeus,* and *Conger vulgaris,* its amount being in an inverse ratio to the quantity of iron present. The blood of *Helix pomatia* also contains much copper, the part of the ash insoluble in water yielding 2·57 per cent. Many chemists have detected minute traces of copper even in human blood, and twenty years ago Deschamps arrived at the conclusion that it is normally contained in the blood of man and animals, being in the first place taken up by plants from the soil. Odling and Dupré have indeed subsequently detected copper in flour, straw, hay, meat, eggs, cheese, and other articles of food. It is not, therefore, difficult to perceive whence the Touracos, or plaintain-eaters, derive the copper which their red feathers contain. The vegetable food on which they subsist doubtless contains this metal, and I have indeed succeeded in obtaining indications of copper from the ash of three fruits of a plantain, the common *Musa sapientum,* purchased of a London fruiterer. There is, of course, still room for experiment and further observation in this direction. Researches as to the sources of copper whence vegetables assimilate it, the occurrence of ores of copper near the habitats of the Touracos, and its detection in the articles of food supplied to these birds when kept in captivity, will doubtless lead to interesting results. I am now pursuing these inquiries, and at the same time completing the investigation of those properties of turacine which have been outlined in the present paper.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

CHAPTER II.

THE WOMEN OF TEUTONIC MYTHOLOGY AND ROMANCE.

At the close of our preceding chapter, we left Western Europe on the eve of a mighty revolution. We must not suppose that its dominant population belonged any longer to the old Celtic races, but, on the contrary, it was a mixture—we may fairly say an amalgamation of different races from many parts of the Roman empire. In the few instances I have already given, we have Vangiones from Belgium, in one of the towns in the north of Britain, and people from Salona in another, and we have seen people of Greek origin at Lyons, on the Rhone. It was the policy of the Romans to colonize permanently the territories they had conquered in more distant and less civilized parts, and the first towns in these parts were Roman military colonies, and the inhabitants soldiers, with their relatives, and people who accompanied them. In most places, each town, or station, appears to have been occupied by an uniform population from the same country, and to have been generally recruited from that same country; but in course of time the circumstances altered, and the soldiers, or, in other words, the townsmen, were recruited from any part of the Roman empire most convenient. The population became thus very mixed in its ethnological character; but this was probably not outwardly observable from the circumstance that it had all become outwardly Roman. This was, no doubt, still more the case in Britain than in Gaul, in some parts of which the original Celtic population had possessed towns before the Roman conquests. The great source from which the population was thus recruited in Northern Gaul and Britain during the later Roman period appears to have been Germany, and many facts lead us to believe there was in these countries a very considerable population of Teutonic blood long before the time when the authority of Rome was withdrawn. Our second chapter

thus introduces us to that great Teutonic race, from which we ourselves claim to be descended.

Fortunately, too, with our German forefathers, the materials of history begin to be clearer and more copious, and we shall soon be able to treat our subject much more satisfactorily. But before we consider the primitive Teutons as they lived upon this earth, we will pay a visit to them in their heaven above, for it should be in their mythology and mythic romance that we shall be able to learn the Teutonic *idea* of Womankind. The outline of the primitive mythology of our Teutonic race has been preserved to us in the two Eddas, the first of which consists of a series of the early Scandinavian mythic poems collected in the latter part of the eleventh century by a priest named Sæmund; the other, which is known as the Prose Edda, formed, about half a century later, chiefly from the songs of the elder Edda, by another priest named Snorro.*

According to this Scandinavian mythology, there were three principal worlds, or, as they called them, gards, *i.e.*, yards, or inclosed residences. Towards the south was Asagard, the residence of the Asas, or gods; to the north was Utgard, or the outer residence, otherwise called Jotunheim, or the home of the Jotuns (in Anglo-Saxon eotens), or giants; and between them lay Midgard, or the middle residence, which was the earth, inhabited by men. The giants, or evil beings, had existed before the gods, and therefore, through longer experience, possessed greater knowledge of things. The oldest and highest of the gods was Odin, as he was called by the Scandinavians, or Woden, as the name was pronounced in the German dialects, including our Anglo-Saxon. Odin had many names and epithets, but he was most commonly spoken of as Allfadur, or the Father of All things. His wife was the goddess Frigga, who was spoken of as the Mother of All; and from them were descended the other gods and godesses. Odin was in possession of the precious liquor, the drinking of which produced poetry, and which he had stolen from the dwarfs in a rather dishonest manner. It was the etiquette among the gods to talk in verse, and the language of poetry, whether we find it in the primæval dialects of Scandinavia, or in Anglo-Saxon, is full of metaphor and imagery, which, though often extravagant, is sometimes remarkable for its beauty. Several of these metaphorical phrases have relation to Womankind. Thus Odin himself is called Friggiar faþmbygguir, *i.e.*, the inhabitant of the bosom of Frigga, meaning her husband;

* The edition I use of the Poetic Edda, or Sæmund's Edda, is that of Copenhagen, in 3 vols., 4to.

and similiarly Loki, the least worthy of the gods, is spoken of in another of the Edda songs, as Farmr Signyiar arma, the burthen of the arms of Signyia, his wife. Still more elegant was the metaphor usually employed in Anglo-Saxon poetry for a woman—freóðu-webbe, a weaver of peace. In Beowulf, it is said of the hero's aunt Hygd, the wife of Hygelac, whom she was accused of having murdered—

ne bið swylc cwénlíc þeáw,	such is no womanly custom,
* * *	* * *
þætte freóðu-webbe	that a peace-weaver
feores onsæce,	plot against the life,
æfter lig-torne,	after burning anger,
leófne mannan.	of a dear man.
"Beowulf," l. 3884.	

And at the opening of the fragment called the Gleeman's Tale, we are told that Widsith travelled in company with his wife to visit the Hreth-king's court—

he mid Ealhhilde,	he with Ealhhild,
fælre freóðu-webban,	faithful peace-weaver,

that is, faithful woman. The beauty of the metaphor will be still better appreciated if we bear in mind that the chief domestic occupation of Womankind among the different branches of the Teutonic race, was weaving. It is an assertion of one of the most precious attributes of the sex. The principal building in Asagard was Walhalla, the Hall of Slaughter, in which the souls of men who fell bravely in battle, lived and feasted. Odin had a high seat or throne, from which, when seated upon it, he overlooked the universe, and on which none of the Asas was permitted to sit, except Odin and Frigga.

Once, in the morning of time, to use still the metaphorical language of this old poetry, the Allfather was sitting upon his seat, and the Mother of All sat by his side. The god, like a good husband, said to his spouse, "Give me thy counsel now, Frigga, for I have an earnest desire to visit Vafthrudnis, and to dispute with that all-knowing giant on points of ancient knowledge." Frigga, who knew that it was a long journey beset with dangers, and that Vafthrudnis was the strongest, as well as the most learned, of the giants, would have persuaded Odin to remain at home; but she found him resolutely bent upon the adventure,—like some husbands of more earthly character, he had evidently made up his mind what to do before he asked his wife's advice upon it; and, seeing this,

the goddess gave him affectionately her parting wishes for his safety. For those who may wish to know what was the language spoken by the Mother of All, I repeat her words as they are given in the opening of the Edda. Frigga said to Odin—

heill þu farir !	safe be thou in going !
heill þu aptr komer !	safe be thou in coming back !
heill þu Asynnom ser !	safe be thou for the goddesses !
öþi þer dugi	may thy talent be sufficient
hvars þu scalt, or alldafauþr,	wherever thou shalt have need, our Allfather,
orþom mæla Jotun.	to address the giant with words.

Odin seems to have had two objects in view—first, to obtain knowledge from the all-knowing giant, which he proposed to do by going in the diguise of a poor traveller, and drawing out from him information which he would not otherwise give; and, secondly, to spy the country, or, as he expresses it, to see what sort of halls Vafthrudnis lived in. Accordingly, Allfather presents himself in disguise under the name of Gangrad, the traveller, and the rest of the poem is a continuous conversation between the Asa and the giant, so arranged as to give an elementary outline of the primitive mythology. Here and there, among these obscure songs of a remote age, we gain a hint of the position of Womankind among the gods. In the För Skirnis, or Journey of Skirner, who went to gain the love of Gerda for Thor's son, Njörd, the daughter of a Jotun, the damsel acts quite independently of her father. In the Harbarz Lioth, or Song of Harbard, the ferryman, in which Thor, Odin's eldest son, and the first of the gods under him, and Harbard tell each other their adventures, to the question, "What wert thou doing, Thor?" the god replies, "I was beating the wives of the giants in Hlesey, for the wickedness they had perpetrated towards mankind." Harbard then remarks, "It was a disgraceful act that thou committedst, Thor, when thou gavest blows to women." Thor felt the reproach, and excused himself by urging that these were wolves rather than women. Facts like these show us woman, according to the primitive ideas of our race, in a position of dignity far different from that of savages.

In the songs of the Edda, the goddesses are not only represented as sitting in the hall on an equality with the gods, but they also meet in council together on the same footing, and give their opinions, which are listened to with respect. At the opening of the Vegtams-Quitha, we find the Asas of both sexes thus assembled in council to debate on the danger with which the young Baldur

had been threatened in a dream. In Thrym's Quida, likewise, the gods and goddesses sit and act together in the council held to consult on the proposal to disguise Thor in the dress of a bride. In the Ægis-Drecka, or Æger's banquet, the social position of the goddesses is quite equal to that of their husbands, they take the same share in the conversation, and come in for the same share of the insults of the base Loki, the most wicked of the gods. According to this story, Æger gave a great feast to the Asas, to which came Odin and his wife Frigga. Thor came not, as he was absent in another part of the universe, but his wife, Sifia, attended alone. Among others present at this entertainment were Bragi, and his wife Idunna; Njörd, and his wife Skadi, and Freyja, the goddess of Love. Loki, who was one of the party, showed his natural perversity by slaying one of Æger's attendants, in consequence of which he was expelled from the hall, and forbidden to return. Nevertheless, he soon presents himself again, and demands his horn of mead. He is received in silence, with the exception of a gentle rebuke from Bragi; but a seat is granted him, and he takes his place, and drinks to the assembled Asas, excepting Bragi, whom he accuses of cowardice. Bragi replies, and his wife interferes to prevent an unseemly brawl; but Loki insults Idunna, and charges her with disgraceful licentiousness. The goddess Gefion, who was celebrated for her chastity, is subjected to a similar charge, nor are Frigga herself, or Freyja, the goddess of love, or Skadi, or any of the other goddesses, spared from the same or even worse imputations, until Thor makes his appearance, and drives away the turbulent intruder. If we judge by the imputations thus freely scattered among the goddesses by Loki, we might be led to form a rather low estimate of their characters; but the old writers intimate that the greater part, at least, of his charges were no better than a mere ungrounded libel. Yet we learn from other parts of the Eddas that neither goddesses nor gods were totally unacquainted with intrigues, and in this respect, indeed, they seem to have resembled, to some degree, the deities of classic fable. Most of the gods of the Teutonic mythology had several wives—the number of Odin's wives was rather considerable—so that polygamy was certainly countenanced in Asagard.

A list of the goddesses of our primitive mythology, with their character, is given in the prose "Edda," or "Snorro's Edda." Eir was the goddess of medicine. Gefion was the maiden goddess, and all females who died maids became her handmaidens. The fifth in

the Edda list was Fulla, who was likewise a maid, and who went with her hair flowing over her shoulders, and her head adorned with a gold ribbon. She was entrusted with the toilette and slippers of Frigga, and was the confidential repository of her secrets. The next of the goddesses in rank after Frigga, the Mother of All, was Freyja, who possessed the celebrated necklace Brising, answering to the cestus of Venus, who holds in classical mythology nearly the same position as Freyja in that of the North. The goddesses of Asagard are almost all gentle and affectionate in temper. The husband of Freyja is described as leaving his wife in order to travel into very remote countries; the goddess, after wandering through many countries in vain search for him, returned home, and passes her time in continually weeping for his absence. She weeps tears of gold. The "Edda" song, "Fiöl-Svinns Mal," concludes with a passage describing, in simple but touching terms, the joy of two lovers of the Asa race on their re-union after a long separation. Several of the goddesses presided over the affections of men and women, and over affairs of love. There were different classes of goddesses of inferior rank, such as the Valkyrier, who were present at battles, and selected those who were to be slain, and the Norni, or fates. Even these seem to be gentle and affectionate, when not engaged in their sanguinary duties, which, too, were looked upon as beneficent acts, as it was considered the greatest of God's bounties to take a man direct to Walhalla. The Valkyrier waited upon the heroes in the hall of Walhalla. It was, indeed, one of the great duties of the high Teutonic dame, to serve the mead or other drink to her husband's guests in the hall.

Our information on the costume of the fair goddesses of Asagard is unfortunately very scant. They were evidently proud of adorning their persons with a profusion of jewellery. Freyja had rings of gold on her hands, and a necklace of gold round the neck. The latter seems to have been a usual ornament; one of the heroines of the "Edda," Menglad, took her name from the brilliance of her necklace. The goddesses appear to have been especially proud of the whiteness of their arms, which they washed diligently. In the "Ægis-Drecka," Loki compliments Idunna on her arms being "excellently washed" (arma þína ítr-þvegna). From this we may assume that the dress had no sleeves, but that the arms were left bare. The material appears to have been usually linen, which they wove at home. In the "Thryms-Quida," Freyja is recommended to put on her "bridal linen" (brudar líni). In this particular case, we have, at all events, some account of the manner in which a

goddess dressed for her marriage. Thor had lost his famous hammer, which was in the power of Thrym, one of the Jotuns, or giants. Thrym refuses to give it up on any other condition than that Freyja shall be given to him for a wife. Loki persuades Thor to go with him to the court of the Jotun disguised in the garb of Freyja, and act the part of the bride. Accordingly they bound round Thor the bridal linen, placed round his neck "the great glittering necklace," made the keys ring under it, and the female vest (kvenvâþir) to flow about the knees. The keys were hung to the girdle as symbolical of the duties and cares of the new bride. They placed broad gems on his breast, and a band round the top of his head. It appears to have been the custom to cover the bride with a thick veil on these occasions, and Thor's disguise proved safe except in as far as he nearly betrayed himself by his own indiscretion; for the god, who was renowned for his appetite, was no sooner seated at the table in Thrym's hall, than he eat without halting an entire ox, eight salmons, and all the dainties which are usually served to ladies under such circumstances, and with it he drank three hogsheads of mead. Thrym, giant as he was, felt somewhat surprised at the appetite of his betrothed, and said, "I never saw a bride eat more at a meal, or a maiden drink a larger quantity of mead." Loki excused her by stating that so anxious had she been for the time when she was to go to Jotenheim, that she had eaten nothing for eight days and eight nights. Thrym next sought to obtain a glance at the face of his bride by lifting up the corner of her linen, but he drew back in terror, with a remark on the fierceness of her eyes. This is explained by the assertion that she had not slept during eight days and eight nights. At length the hammer is produced, and the moment Thor feels it in his hand he assumes his true character, and destroys Thrym and all his household.

From Asagard and Walhalla, we come down to Odin's more distant descendants, who have not yet passed under the judgment of the Valkyries; and whose sphere of action lies within the limits of Midgard, or this earth. Their legends, some of which occupy a part of the Edda songs, bring us out of the region of pure mythology into that of romance, and to the very bounds of history itself. In them, Womankind oft takes a more boldly-defined position than in the mythology. The great qualities of woman often influence, either for good or for evil, the whole course of events more powerfully than those of man. In fact, in these mythic romances, woman begins to appear as the great moving

force of the history. There is one great cycle which runs through a number of the later songs of the Edda, and which may be taken as an example of the earlier class of these romances. It will be remarked how it rises out of the merely mythic and poetical into something like the real. The great family of the Volsungs, descended immediately from Odin, was represented at the time when this story begins by a prince named Sigurd, who had obtained the power of understanding the language of birds. One day he heard the birds talking of a beautiful maiden whose name was Brunhild, and who waited for a liberator of the other sex. She was a Valkyrie, who had offended Odin, and in return had been condemned to abandon her condition of Valkyrie, to submit to marriage, and to be subject to death. She had been thrown, clad as she was in her armour, into a magic sleep, and placed on the top of a mountain surrounded by a barrier of flames; the hero who should pass the fiery barrier and rescue her, was destined to be her husband. Sigurd resolves to undertake the adventure, and succeeds, but he leaves Brunhild with a promise upon oath to return and take her away as his wife. Sigurd then proceeds to the country of the Niflungs, and forms a friendship with their three kings, the brothers Gunar, Hogni, and Guttorm. Their sister Gudruna becomes enamoured of him, and, through a magic potion administered to him by her mother, he forgets his vows to Brunhild, and marries Gudruna. Sometime afterwards, Gunar, the eldest of the three brothers, hears the story of Brunhild, and determines to obtain possession of her. He secures the assistance of Sigurd, who alone has the power of passing through the flames, and by this means Brunhild is brought away and married to Gunar. But the Valkyrie retains her passion for Sigurd, and had forgotten nothing that had passed, and she now only seeks to punish him for his desertion. She excites her husband Gunar and her brothers against him, and in the sequel Sigurd is slain by them. Brunhild immediately repents of her deed, laments the fate of Sigurd, slays herself, and is burnt on the same funeral pile, leaving her curse upon Gunar and his brothers. The Edda songs go on to tell the vengeance which fell severally upon the three princes of the Niflungs. Subsequently their sister Gudruna makes her appearance again as the wife of Attila, whom she slays at a feast; and the story continues through a new series of feuds and slaughters.

These Edda songs, which present the earliest form of what was afterwards expanded into the grand German mediæval romance of the Nibelungen-Lied, or song of the Nibelungs, picture Woman-

kind not in her most pleasing colours. We have in our Anglo-Saxon literature only one representative of these mythic romances, the poem of Beowulf; but we cannot but feel that in this venerable relic left to us by our forefathers, the other sex appears to us more domestic in character, and in more amiable colours, than in the story of Brunhild. The name of Beowulf figures as one of the early links in the Anglo-Saxon mythic genealogy of the race of the Anglo-Saxon kings.

Hrothgar was a king in Denmark, who had built for himself a princely residence, to which he gave the name of Heorot; but it was visited by a fiendish being named Grendel, who carried off Hrothgar's nobles to devour them in his retreat, and none had the power to resist. Beowulf reigned over the Geats, or Goths of West Gothland, and, hearing by fame of the distress of Hrothgar's court, he proceeded thither with a party of his warriors, in the true character of the mythic hero, in order to combat the monsters. Beowulf is joyfully received in Hrothgar's hall, and the scene of feasting, the story-telling, the minstrel's song, the boisterous mirth, are all graphically described. Then, in due time, Hrothgar's queen, the noble Wealhtheow, the "gold-adorned" (gold-hroden), advanced from her seat, to bear the cup to the warriors. First she offered it to the king her husband, greetingly "bade him be blithe at the beer-drinking, he who was dear to his people." Then she went round the hall, offering the cup, and distributing gifts to each. At length "the ring-adorned queen, exalted in mind," bore the mead-cup to Beowulf himself, and "sagacious in words" (wisfæst wordum), addressed the hero in flattering terms. Beowulf replied that he intended to destroy the Grendel or die in the attempt. There and then:—

eóde ġold-hroden	went gold-adorned
freólicu folc-cwén	the joyful people's-queen
to hire freán sittan	to sit by her lord.

"Beowulf," l. 1285.

The "joy in hall" was then renewed, until Wealhtheow retired to her bed, and Hrothgar soon followed. I will not enter into the details of the combat in which Beowulf gave the Grendel its mortal wound: other feasts in the hall followed, in which the queen, to whom the poet applies the epithet of "peaceful tie of peoples" (friðu-sibb folca), rewarded the hero with princely gifts, while Hrothgar's daughter carried round the cup.

We see that there is not much scope in "Beowulf" for bringing

forward the character of the female sex; and unfortunately we have no other Anglo-Saxon romance of the same class left in anything like its original state. There is one other early romance, however, which is worthy of attention. It is that of Walthere, Latinized into Waltharius, and preserved only in a Latin metrical version, supposed to have been made in the tenth century.*

It was the age when Attila with his Huns was ravaging the centre of Europe, and he was already directing his march against the kingdom of the Franks, when Gibico, who was then their king, took counsel of his nobles, and resolved to save his people from the horrors of invasion, by making his peace with Attila, and paying him a tribute. The offer was accepted, and a young Frankish noble, named Hagano, was delivered as a hostage, accompanied with a large mass of treasure. Attila now turned his arms against Burgundy, where Herric was king, who had an only daughter named Hildegund, remarkable for her beauty. Herric followed the example of the king of the Franks, made his peace with Attila, and his daughter Hildegund became his hostage. The Aquitanians submitted to the same conditions, and their king, Alphere, gave as hostage his son Walthere, a young prince of great promise. Now Herric and Alphere had already entered into a treaty for the marriage of Walthere and Hildegund, so that the couple, ignorant of the engagement made by their fathers, went into exile together. It is an example of the authority of a father over his children. So Attila returned with his hostages into Pannonia, where they were treated at his court with great kindness, as though they had been his own children, and the maiden was given in charge to the queen. The two young princes were trained to arms, and became distinguished among the warriors of Attila's army; while the maiden rose rapidly in the favour of his queen, whom she pleased by her noble manners, and by her industry in her domestic duties, until she was at length made keeper of the royal treasures, and her influence was almost equal to that of the queen herself.

> "Moribus eximiis operumque industria abundans;
> Postremum custos thesauris provida cunctis
> Efficitur, modicumque deest quin regnet et ipsa."
>
> "Waltharius," l. 112.

We have seen in "Beowulf" that it was the lady of the household who distributed the gifts of her husband's treasures to his guests

* The "Waltharius" has been printed several times. The edition I use is that by M. Edélestand du Méril, given in his "Poésies Populaires Latines," Paris, 1843.

in the hall, and she appears also to have had them in her keeping. During this time the king of the Franks died, and was succeeded by Gunthere, who immediately threw up his dependence upon Attila, and refused his tribute; and the Frankish hostage, Hagano, made his escape from Attila's court, and fled back to his home. But Walthere remained one of the most distinguished leaders in the army of the Huns, and their king, at the suggestion of his wife, sought to retain him by pressing upon him a Hunnish wife. But Walthere found, or pretended to find, an excuse for declining this proposal in the plea that the attractions of a female companion might withdraw him from, or make him less eager in, his path of glory. At length, on his return from a great victory he had gained for the Huns, Walthere, in a private interview with Hildegund, becomes enamoured of her while she is offering him the festive cup, still ignorant of the treaty of alliance which their fathers had formed for them. The result is, they agree to fly together, and make their way to the land of the Burgundians. As the opportunity for their escape, they choose a great feast-day, at which Walthere contrives that the whole royal household shall be made more drunk than usual, and, when they are all stretched helpless on the floor, he selects a swift horse from the stables, arms himself, and carries with him part of the king's most valuable treasures, and with his lover makes for the forest. Their adventures on the way, their dangers and escapes, the patience and constancy of the lady, and their final success, form the subject of the remainder of the poem. The romance of Walthere may be considered as belonging to that branch of the Teutonic race which established itself in Gaul.

VARIATIONS OF ANIMALS AND PLANTS UNDER DOMESTICATION.*

Charles Lyell and Charles Darwin are the two men who have most deeply affected the tone of scientific thought of the present generation. The one, assisted by a host of followers, has abolished spasmodic geology, and the other has contributed more than any other writer to suggest views of development in affinity with that exceedingly slow and orderly progression of the physical frame of the earth from one stage to another, which palæontological and

* "The Varieties of Animals and Plants under Domestication." By Charles Darwin, M.A., F.R.S., etc. 2 vols., with illustrations. John Murray.

lithological investigations have established beyond a doubt. The Darwinian theory may or may not account for the whole range of facts involved in the "Origin of Species," but the principles expounded by Mr. Darwin cannot be denied to exert, at the present time, a very important action upon organic beings, and to have exerted a similar action in past periods to an extent which must have been enormous though its limitations are unknown. Formerly, with the exception of a few daring minds, speculative science tried to accommodate itself to the prevailing theory that our globe was a novelty of some six thousand years date. Geology has completely overthrown this notion, and it is remarkable that while students of this particular science have made increasing demands upon time, they have been followed by investigators in almost all departments of knowledge. The ethnologist, the philologist, the anthropologist, the cultivator of the new and rising science of comparative mythology, all require the lapse of ages to account for the phenomena which their researches disclose, and the astronomer, reinforced by recent discovery in the belief in what is called the "nebular hypothesis," regards our planet as a portion of a system to which a great, though at present an incalculable antiquity must be assigned. Objections to Darwinism founded upon the time required for the supposed methods of operation now only linger in those portions of society which, considered from a scientific point of view, must be regarded as the least informed; but difficulties of other descriptions remain scarcely touched by accumulation of facts or by ingenuity of hypothesis. The opponent of Darwinism who repeats the old demand for connecting links, is indeed satisfactorily answered to a certain extent. Originally his question was based upon the belief that if numerous so-called species had descended from a common ancestor, or pair of ancestors, the transition forms ought to be abundantly discovered in living beings, or in the geologic record. If, instead of having to account for all the known changes in organic life, and in the structure of the earth-crust, by the supposition of causes acting very slowly and gradually, philosophers had only been allowed to add a few thousand years to the accepted chronology, they must have supposed natural operations so crowded together that the earliest parents and their remotest descendants could have been but slightly separated from each other, and immense portions of the whole scheme might have been simultaneously viewed at a single glance. But this is known not to be the case. Little progress has been made in converting geologic time into historic time, but the scheme of organic life as

unfolded by modern discovery, is so vast in its extent, that theories of development which did bring organically remote links into close chronological approximation, would, for that very reason, be rejected as untrue.

The sudden appearance in cultivated plants of characteristics divergent from the parent stock, and capable of hereditary transmission has been deemed to supply valid arguments against Mr. Darwin's system, which involves the belief that important changes have, for the most part, been extremely slow; but facts of this kind, lessened in value by the well-known tendency of the offspring of varieties to go back to ancestral forms, do not give much help to account for the extent of change that has taken place, or for the expenditure of time which there is evidence to show actually occurred. Spasmodic geology might account for the disappearance of one race of creatures, and special miraculous interposition might be assumed as the cause of another race of creatures taking the place of those which had been summarily swept away; but if the advocate of such notions complains that Mr. Darwin does not show sufficient connection between the present and the past, it may be retorted upon him that palæontology exhibits more resemblances between the fauna and flora of distant periods than ought to exist upon an hypothesis of frequent cataclysms and fresh creations.

If Darwinism is to be proved inductively, it must be conceded that the transition from simple invertebrate to vertebrate forms, from one vertebrate form to another, has to be exhibited by facts not yet known to exist. If it is to be proved deductively, we must be in possession of biological laws not yet discovered; but no science progresses without theory, and the Darwinian theory is entitled to provisional acceptance until a more probable one appears. Experience and observation, however industriously carried on, do not suffice unless they are made upon a system, so that they affirm or deny definite propositions. A new and unexpected fact may occur in the experience of two men—one supposes it may be correlated with certain other facts, and makes observations or experiments to find out if this is the case; the other observes or experiments without any distinct purpose. The first may arrive at an important law, or generalization, while the latter can at best only increase our stock of disjointed facts. Mr. Darwin's hypotheses are certainly admirable aids to a philosophical method of inquiry; and if, notwithstanding the amazing amount of research displayed in his present work, he has not materially affected the probability pre-

viously attaching to his speculations, he has more fully shown the ground on which they stand, and suggested almost innumerable directions in which further inquiry must be made.

In another work which is to follow the present one, he proposes to deal with the variations of organisms in a state of nature; and in a third work, to try the principle of natural selection by ascertaining how far it will account for the entire group of facts brought together in his previous publications.

A large part of the present work is devoted to elaborate details not given in his "Origin of Species." The additional evidence of this kind is highly important, but the greater part of it is confined to a few groups of animals on which man has exercised his ingenuity from early historic times to our own day, such as dogs, horses, cattle, pigs, rabbits, and poultry, in which latter term we may shock fanciers by including pigeons. As domesticated dogs date back to the days when pre-historic races formed the well-known "kitchen middens," it is not astonishing that the origin of the animals should be exceedingly difficult to trace, and Mr. Darwin inclines to the belief that they have descended from several wild stocks, much modified by breeding and human selection. Different breeds of dogs would certainly have been taken for different species, if their bones only had come down for the anatomist to examine. Isidore Geoffrey St. Hilaire "has shown that in size some dogs are six times as long, the tail being excluded, as others; and that the height relatively to the length of the body varies from between one and two, and one to nearly four." Cuvier remarked that their skulls differ more from each other than those of any wild species belonging to the same genus, and there are differences in the number of their teeth. Within very moderate periods, great changes, capable of hereditary transmission, have been produced in breeds of dogs, and Mr. Darwin adduces some curious facts concerning the effects obtained by crossing. Thus, "Lord Orford crossed his famous greyhounds which failed in courage with a bull-dog—this breed being chosen from being deficient in the power of scent: 'after the sixth or seventh generation,' says Youatt, 'there was not a vestige left of the form of the bull-dog, but his courage and indomitable perseverance remained.'"

Dogs, pigeons, fowls, and horses afford instances in which man, by careful breeding and selection, has made amazing changes. Cats have not offered the same facilities, as "from their nocturnal and rambling habits, indiscriminate crossing cannot without much trouble be prevented." With pigs man has been extremely suc-

cessful in producing variations from wild types, and the figures which illustrate Mr. Darwin's book bring this fact very strikingly into view. No one can suppose that very long-nosed and short-nosed pigs would have been taken for the same species if their bones only had been known. Rabbits, again, show the power of domestication and selection in modifying the skull, the vertebræ, the ribs, the scapulæ, and other bones.

In the "Origin of Species," the variations in the structure and form of pigeons was much dwelt upon. In the present volume many fresh illustrations are given, and are followed by a series of important facts concerning domestic fowls, in the study of which Mr. Darwin has been valuably aided by Mr. Tegetmeier. Naturalists suppose the varieties of domestic fowl to be all descendants of the *Gallus bankiva*, though they vary in weight from one pound to seventeen, and differ, as every visitor to a poultry-yard knows, in the form of the skull, the plumage, the presence or absence of combs and wattles, and a host of other particulars. Abundance of supposed good species, founded upon osteological and other distinctions, would have been made of fowls, if their fossil remains only had been known.

It is exceedingly curious to pass from cases in which man has succeeded in producing great variation, to such an instance as that of the goose, in which comparatively little change has been made for hundreds of years.

The plasticity of some species of domestic animals, and the comparative fixity of others, is probably parallelled in wild ones, and natural causes must frequently isolate particular groups, and check promiscuous crossing in a manner analogous to the operations of man. It is evident also that different animals possess a widely varying amount of power of accommodating themselves to, or being influenced by changes in climate or other physical conditions.

Cultivated plants offer numerous instances of great change having resulted from artificial selection and cultivation, and afford very curious illustrations of some of the laws of variability. Thus, when Colonel le Couteur began his endeavours to raise new varieties of wheat, he chose the best ears, "but soon found that the grains in the same ear differed, so that he was compelled to select them separately; and each grain generally transmitted its own character." Wheat appears to exhibit considerable tendencies to variation, though many of the differences would not be noticed by common eyes. Thus, Professor la Gasca recognized "twenty-three sorts in a field belonging to Colonel le Couteur, supposed to be at least as

pure as any of his neighbours." Professor Henslow observed similar facts.

Maize appears to have afforded a very remarkable instance of modification produced by climate. A tall kind, brought from the warmer parts of America, and cultivated in Germany by Metzler, gave the following results: "During the first year, the plants rose twelve feet high and few seeds were perfected; the lower seeds in the ear kept true to their proper form, but the upper seeds became slightly changed. In the second generation, the plants were from nine to ten feet in height, and ripened their seed better. . . . In the third generation, nearly all resemblance to the original and very distinct parent form was lost. In the sixth generation, this maize perfectly resembled a European variety;" but "was distinguished by a somewhat more vigorous growth."

Peaches supply very interesting illustrations of variation. In the first place, there is considerable though imperfect evidence, that our peaches are descended from almonds, and numerous instances are on record of peach-trees producing nectarines; and Mr. Rivers has produced peach-trees from nectarine stones. "With respect to the more curious case of full-grown peach-trees suddenly producing nectarines by bud-variation (or sports, as they are called by gardeners), the evidence is superabundant. There is also good evidence of the same tree producing both peaches and nectarines or half-and-half fruit—by this term I mean a fruit with one half a perfect peach, and the other half a perfect nectarine."

The known variations of plants and animals of the same species from what would be deemed normal specific types are so great as to involve the definition of species in very grave difficulty. Where does variety end and species begin? Nor does the difficulty disappear by the introduction of such tests as sterility and fertility, for hybrids are not always sterile, as they ought to be, if the test were absolute, and both animals and plants have their fertility much affected by the conditions under which they live. In animals of the same species the periods of gestation are found to vary in different breeds, so that neither can this test be rigidly applied. It is obvious that as absolute sterility cannot be predicated of hybrids in general, comparative, or relative, sterility must be a very uncertain test of specific differences, unless some fixed degrees of these qualities can be agreed upon as sufficient to mark varieties and hybrids, and there does not seem to be any chance of such standards being determined. Mr. Darwin fully recognizes the importance of the fact that while crosses of varieties are often more fertile than their

parents, "crosses of species and their hybrid offspring are almost invariably in some degree sterile;" but he considers the hypothesis of Pallas probable, that "domestication eliminates the tendency to sterility, which is general with species when crossed." He adduces reasons for believing that our domestic dogs are descended from several wild species, and that the same is true of our sheep and our pigs. The latter are referred back to "at least two specific types, *S. scrofa* and *S. Indicus*, which probably lived together in a wild state in South-eastern Europe." He observes that "a wide extended analogy leads to the belief that if these several allied species, in the wild state, or when first reclaimed, had been crossed, they would have exhibited both in their unions and in their hybrid offspring some degree of sterility. Nevertheless, the several domesticated races descended from them are now all, as far as they can be ascertained, perfectly fertile together."

Domestication of animals causes them to be supplied with suitable food in appropriate quantity, and at regular times. It also leads to the preservation of good specimens, and the destruction of bad ones, and to defence from enemies of various kinds, and from inclement weather. Natural conditions must sometimes provide similar advantages, and might be expected to produce analagous results. Domesticated species and varieties appear more fertile than wild ones, and wild ones frequently lose their fertility under confinement. The numerous facts brought together by Mr. Darwin on these, and closely-allied subjects, are well worthy of profound attention; but we must pass on to another branch of his subject, the "Causes of Variability."

We naturally look to change of conditions as a probable cause of variation in offspring, and very instructive information on this subject is afforded by horticulturalists. Thus the doctrine that excess of food induces variability is supported by the statement of Messrs. Hardy and Son, of Maldon, that when they want to keep seed true, they grow it on poor land. In growing for quantity they employ rich land, and "sometimes have dearly to repent of it," because an unwelcome departure from the required type appears. Newly introduced flowers, it seems, do not vary for some time, but, in the course of a sufficient number of generations, varieties appear. Mr. Salter remarks, "Every one knows that the chief difficulty is in breaking through the original form and colour of the species, and every one will be on the look-out for any natural sport, either from seed or branch. That being once obtained, however trifling the change may be, the result depends upon

himself." M. de Jonghe, who has had so much success in raising new varieties of pears and strawberries, remarks with respect to the former, "There is another principle, namely, that the more a type has entered into a state of variation, the greater is its tendency to continue doing so; and the more it has varied from the original type, the more it is disposed to vary still further." Wild animals under domestication usually take time to vary, though not always. Thus the wild ducks in St. James's Park lost their true plumage after a few generations, but in the first generation the Australian dingos, bred in the Zoological Gardens, produced puppies marked with white and other colours. Mr. Darwin remarks that these dingos had probably been previously kept in a domesticated state by the natives; but with respect to horses in South America, Azara noticed that while wild specimens on the Pampas were always one of three colours, and wild cattle of a uniform colour, semi-domesticated animals of the same kind exhibited a great diversity of colour.

Crossing appears to have a variable effect, sometimes leading to new varieties, and at others to "atavisim," or the reappearance of some ancestral peculiarity not shown by the immediate parents.

Cultivators of flowers record their experiences of departure from the expected type in particular seasons. Thus in 1861 many varieties of rose "came so untrue to character, that it was hardly possible to recognize them," and similar instances are given of other plants. In such cases, meteorological conditions appear to have incited the variation.

The changes which we recognize may often be preceded by other changes that escaped our notice, and consequently are really less abrupt than they seem. Thus it has been observed that the cochineal insect only flourishes on its native kind of cactus, and will not thrive on the same species from other localities, or on a so-called native kind formerly introduced at Kew. The insect thus finds a difference not visible to man.

External conditions can only act upon capacities for variation possessed by plants and animals, and these capacities vary greatly in amount in different species; so that while some remain nearly unchanged under a great variety of circumstances, others are easily and quickly affected. Variation induced in one part is usually associated with variation in some other part, and such changes frequently determine whether or not the creature possessing them can live, or must perish under particular conditions.

We do not see that Mr. Darwin has carried us much nearer than

we were before to a perception of the fundamental laws of variation, though he has brought together an amazing amount of information, both as to the extent of known varieties, and the circumstances under which it has arisen.

To account for the remarkable phenomena of inheritance direct from parents, or, in the form of atavism, from remoter ancestors, he has devised the theory of "pangenesis," as he terms it, by modifying older notions on the same subject. This theory starts from the notion that every organized body is composed of cells—taking that term in a very wide sense—capable of reproducing their own sorts, and that special cells belong to each organ or part. An ovum or germ of the entire creature he imagines to contain a multitude of subordinate germs of its several parts, all the lineal descendants of similar gemmules back to the first parent of the whole lot. Ordinary reproduction on such a theory is the result of the development of such gemmules as can reproduce the parental type. Variation comes when other gemmules are brought more prominently into play. According to this theory, put forward as a "provisional hypothesis," "the child, strictly speaking, does not grow into the man, but includes germs which slowly and successively become developed, and form the man. In the child, as well as in the adult, each part generates the same part for the next generation. Inheritance must be looked at as merely a form of growth, like the self-division of a loosely organized unicellular plant. Reversion depends on the transmission, from the forefather to his descendants, of dormant gemmules, which occasionally become developed under certain known and unknown conditions. . . . . Finally, the power of propagation possessed by each separate cell, using the term in its largest sense, determines the reproduction, the variability, the development and renovation of each living organism. . . . . Each living creature must be looked at as a microcosm—a little universe, formed of a host of self-propagating organisms, inconceivably minute, and as numerous as the stars in heaven."

We should certainly hesitate to accept this hypothesis, but it relates to a subject on which no rational explanation has been given. The "cell" is an indestructible entity. Deprive it of walls, of its apparent division into nucleus and surrounding plasma, it still crops up eternally. If we reject the notion that cells visible with a certain optical power are the formative agents in growth or reproduction, we are only driven to a plastic fluid in which higher powers might possibly discover minuter objects to which the term "cell"

would still be applied. Darwinically considered, everything that has hitherto been called a cell is a complex formation containing multitudes of cells. Each animal carries, in a cellular form, the descendants of all the varieties of cells of which all its grandfathers and grandmothers were made up. Such a theory must assume that every organ possessed by the most perfect animal of the present day must have had some sort of an ancestral representative in the earliest and simplest being from which the doctrine of development supposes it to have been originally derived. The cells forming the horns of the stag, or the eye of the man, must have had their ancestral representatives in the simplest form of organic life, supposed to have been the basis of the whole. To say that such a theory is astounding is certainly not to affirm its untruth, but many will rather agree to wait in acknowledged ignorance than accept suppositions so amazing, and resting chiefly upon bold conjecture.

We leave the matter here for the present, with great admiration for the extent of Mr. Darwin's research, and the skill with which he has unfolded one of the grandest and most important subjects on which the human mind can exercise its faculties. We do not, however, understand the statement of his concluding paragraph, in which he says :—"If we assume that each particular variation was from the beginning of all time pre-ordained, the plasticity of organization, which leads to many injurious deviations of structure, as well as that redundant power of reproduction which inevitably leads to a struggle for existence, and as a consequence to the natural selection or survival of the fittest, must appear to us superfluous laws of nature. On the other hand, an omnipotent and omniscient Creator ordains everything, and forms everything. Thus we are brought face to face with a difficulty as insoluble as is that of free will and predestination."

When we consider how very little of the universe we know at all, and how very imperfectly we know any part of it, we are not entitled to assume that the various steps by which a result is reached are not essential portions of one great scheme. The pre-ordination of a result does not necessarily render superfluous the particular law or method by which it is attained, and which we are just as much entitled to call pre-ordained as the result itself. No doubt natural history, as well as human history, which belongs to it, continually plagues us with the old puzzle concerning the existence of evil. The real solution of the problem is beyond our reach, but that is no reason why we should not trust the religious instincts which lead us to the conclusion "that all is well."

A DAY IN THE VICINITY OF SIMON'S TOWN, SOUTH AFRICA.

BY CAPT. G. E. BULGER, F.L.S., F.R.G.S., C.M.Z.S.

ON a pleasant September morning, about three years ago, S—— and I left the barracks at Simon's Town, in Cape Colony, and ascended to the summit of the sandstone hills, which, close behind the town, rise to a considerable height above the sea, and form a sort of craggy wall round the narrow peninsula, whose extreme point is the far-famed Cape of Good Hope. On our left was the Simonsberg, the loftiest part of this mountain border; while, before and to the right of us, stretched a level plateau, strewn with broken rocks, and thinly covered with a stunted and ragged-looking vegetation of a dull greyish-green colour. A wander across the plateau to the sea beyond, and a peep at the birds and flowers which are to be found there, were the chief objects of our excursion; and amply they repaid us for our scramble up the cliffs.

The surface of the plateau consists mainly of white sand, with a sparse growth of greyish, rigid-looking shrubs and lesser plants, amongst which heaths, geraniums, pelargoniums, and proteas are the most prominent. The appearance of the whole is harsh aud uninviting. There is an absence of verdure and softness; and the frequent patches of monotonous-looking sand, which peep out in all directions from amidst the thin wiry grass and straggling bushes, give the place a somewhat desolate aspect, in spite of the brilliant-hued flowers which here, as everywhere else in South Africa, are characteristic of the earth's covering.

On the slopes of the ascent I found many curious and striking plants, and amongst them, *Muraltia heisteria*, with its spiny, furze-like leaves; the *Kreupelboem*, or cripple-tree (*Leucospermum conocarpum*), so called from its ungainly and contorted branches; the strange-looking *Berzelia lanuginosa*, with its imbricated leaves and singular little heads of flowers; several species of *Polygala*; the *Scotia latifolia*, or "monkey boerboon" of the colonists; some *Diosmæ*; two or three kinds of *Rochea*; and *Rhus lucida*, on which the Cape mistletoe (*Viscum capense*) was growing luxuriantly. The beautiful *Diplopappus fruticulosus*, covered with myriads of charming little mauve-coloured, star-like flowers, and *Heterolepus decipiens*, also laden with bloom, were most abundant, and strikingly ornamental, relieving very gratefully the rather monotonous

uniformity of hue presented by the mass of *Mimetes*, *Serruria*, and other proteaceus shrubs, which, with heaths and coarse grass, make up the great bulk of the vegetation: though, here and there, the gorgeous scarlet corollas of *Leonotis leonurus* flash like meteors amidst the broken rocks and glittering sand. On the summit a kind of sheep's sorrel was tolerably plentiful; and the Rev. Dr. Brown, the colonial botanist, to whom I referred the specimens, kindly informed me that he believed it to be identical with our common English species, *Rumex acetosella*.

As we wandered on, fresh objects of interest continually met our gaze. In one place was a large patch of pale-coloured everlastings, their rigid flower-heads faintly rattling in the breeze, while a short distance further on, the yellow spikes of a species of *Satyrium* peeped up from amongst the coarse herbage. Presently we crossed a little foaming brook of dark-coloured water, dashing through a shallow ravine that crosses a portion of the plateau; and, from its grassy margin, started a fine hare (*Lepus capensis*), which scampered away to a group of rocks about a hundred yards distant. Near the edge of this little brook, we also met with about fifty or sixty small locusts, with black bodies, speckled with minute yellow dots, which were resting on the damp sand; and found two or three specimens of that beautiful, but common, and almost ubiquitous, butterfly, the painted lady (*Pyrameis cardui*). These, with the exception of a few beetles, were the only insects I noticed; though, doubtless, had my attention been drawn in that direction, I might have found hundreds of others.

Birds were tolerably numerous, especially the lovely yellow-breasted honey-suckers (*Cinnyris violacea*), and the "little stripe-heads"* (*Fringillaria vittata*), whose sweet, but weak, little songs were constantly breaking in upon the silence of the lonely plateau. A few wagtails (*Motacilla capensis*); sparrows (*Passer arcuata*); and doves (*Turtur semitorquatus*), were also to be seen amongst the rocks and bushes; while, overhead, some half-dozen swifts (*Cypselus leucothea*) were careering in the clear atmosphere. Now and then, a rock thrush (*Petrocincla rupestris*) flew past us; and last, not least, a pair of owls (*Strix flammea*) rushed forth from the shelter of a dark nook, where they had hidden themselves from the daylight, apparently much alarmed at our having discovered their retreat.

Lizards of many kinds were plentiful; and, amongst them, we found the curious black variety of *Cordylus griseus*, described by

* *Streepkopje* of the Dutch colonists.

Sir Andrew Smith in the "Zoology of South Africa;" but the others I did not attempt to identify, as they were common, and not of special interest to me.

During this pleasant ramble, I saw the handsomest *Helichrysum* I ever met with, and secured the only three blossoms which it displayed. They were somewhat oval in shape, small, and regular, and of the richest purple-crimson, reminding me of the colour of the Syrian garnet. The plant was between fourteen and twenty inches in height; the leaves sessile and linear, like those of the heaths, and the florets so lustrous that they glittered in the sun like polished metal. I did not recognize the species, and I regret to say that I lost my specimens, so that I was unable to refer them to some competent authority.

Many plants of *Leontonyx augustifolius* grew here amidst the "heather"; their aromatic, woolly leaves being very nearly as white as the sand in which they lived; and near them I found a strange orchis, which I had never seen before. The blossoms grew in a spike of about eight inches in height; and they, with the whole plant—leaves, stem, and even the roots—displayed a purplish tinge, resembling the colour of red beet-root; the inner whorl of the perianth deeper in hue, and of a more decided purple than the rest. I sent the leaves and flowers to the late Professor Harvey, who informed me that the plant was *Monadenia rufescens*.

* * * * *

In the afternoon, we walked to the circular battery along the beach. It was nearly low tide, and the beautiful white sand afforded us, consequently, better and firmer walking than usual. The air was almost cold, but very pleasant and bracing, while the fresh saline odour of the sea was delightful in the extreme. The walk was a somewhat wild and desolate one, and the silence broken only by the crash of the breakers on the silvery strand, and the deep *sough* of the receding waves, as they rolled back to the bosom of their kindred waters. On our left the sand-hills flanked the beach, rising to unequal heights, and robed with a thin sprinkling of protea, heath, and mesembryanthemum, with the white sand showing between the bushes in patches of various shapes and sizes.

We here saw a cormorant of some description, probably *Pelicanus graculus*, disporting himself on the very crests of the breakers, now sailing gracefully over the glancing water, and anon disappearing beneath the surface, in pursuit of the small fish and marine animals which constitute his food; and further out, almost

in the centre of the bay, was a crowd of gulls and petrels of various kinds.

The vicinity of the battery was gay with the flowers of the Hottentot fig (*Mesembryanthemum edule*), and the glowing scarlet blossoms of a species of *Moræa*, the latter visible, from the brilliancy of their colour, at a considerable distance.

The shadows of night were beginning to fall rapidly ere we returned to the barracks, delighted beyond measure with our day's rambling in the vicinity of Simon's Town.

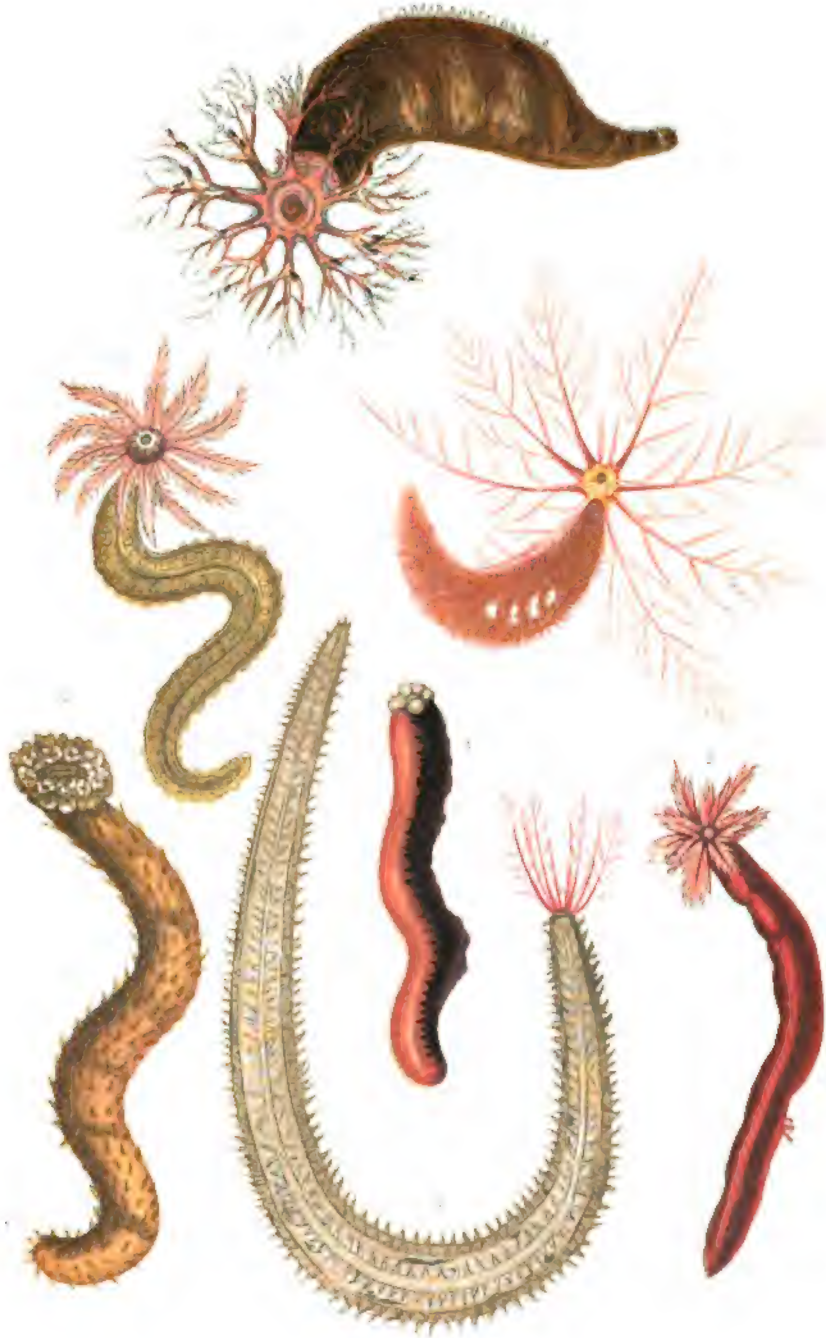
HOLOTHURIÆ; OR, SEA-CUCUMBERS.

BY THE REV. W. HOUGHTON, M.A., F.L.S.

(*With Two Plates.*)

THE creatures which form the subject of our consideration in this paper are very interesting in many particulars. They are popularly known by the name of "Sea-cucumbers," from the strong resemblance some of the species have, when the tentacles are withdrawn inside the body, to the well-known vegetable. Another popular name with sailors and the lads of the sea-side of "Sea-puddings" is sometimes applied to these animals. The scientific name, *Holothuria*, is evidently from the Greek term ὁλοθούριον. It is always advisable to try to get at the meaning of the terms of scientific nomenclature, and to identify, if possible, the animals originally denoted by these terms, and the reasons for applying them; but this is often a difficult task. We meet with the Greek word ὁλοθούριον in Aristotle and other ancient natural history writers, but it is not clear what particular animal or animals were intended by the classic worthies of antiquity, who are generally vague and short in their descriptions. "Many animals," says Aristotle,* "are separate from each other, but incapable of movement, as oysters and the animals called holothuria." It is likely that the Greek word is derived from ὅλος, "whole," and θύριον, "a little door." Hence, from Aristotle's description, it is not improbable that the *Alcyonium digitatum*, with its numerous small polygonal depressions, may be denoted; or, it may be, the large, round, sponge-like alga, called Spongodium, living free on the sea-bed and abundant in the Greek seas. In the muddy bays of the coast of Lycia, Spratt and Forbes noticed many Holothuriæ, "mostly long, chocolate-brown species,

* "Hist. Anim.," i. 1 § 8.



[illegible]

1.—Holothuria phantapus [illegible]
2.—H. [illegible]
3.—H. fusus.
[illegible]
[illegible]
6.—H. [illegible]
7.—H. [illegible]

having their heads garnished by twenty short tentacula, and very sluggish." The Holothuriæ were no doubt known to the ancient Greek fishermen, and it is very probable that they are the animals intended by Aristotle in the following sentence:—"Some experienced fishermen say they have seen in the sea creatures like pieces of wood, black, round, and of the same thickness throughout."* There is no evidence to show that they were ever eaten by the ancients, nor are they now by the modern Greeks, though we know various kind of Echini were highly prized as gastronomic dainties. But whatever animal was denoted by the Greek term ὁλοθούριον, the modern scientific name Holothuriadæ is well defined, and designates that family of cirrho-vermigrade Echinodermata, of which several British species occur on our own coasts.

Let us proceed at once to notice what is most worth recording of this family of Holothuriadæ, and consider (1) their general form and characteristics; (2) the localities where found; (3) their internal anatomy; (4) their curious power of reproducing lost viscera; (5) their classification; and (6) their utility, commercial or otherwise.

(1.) In their general form, Holothuriæ are more or less elongated, and sometimes vermiform; their bodies are furnished with numerous suckers, similar in form to those of the Echini and star-fish, arranged variously according to the genera, and used as organs of adhesion or locomotion. I have before me, as I write, two living species; we notice at the anterior end a circlet of yellowish arboriform tentacula, ten in number, arranged round the mouth; at the posterior end is another orifice, through which we may occasionally see water to be ejected. The body is very flexible, and capable of considerable extension and contraction. The circle of tentacles is often quite concealed within the oral aperture. The skin in the specimens before us is very tough, and reminds one of the coriaceous integument of the star-fish, to which we know the Holothuriæ are evidently allied. We observe five clearly-defined double series of these suckers running longitudinally along the body. In some species the suckers are scattered over the body with no definite arrangement, but generally the quintuple method obtains. In *Holothuria* (*Psolus*) *phantapus* (see Fig. 1) only three rows are developed, and these are placed on a soft disc or foot; two longitudinal furrows along the back indicate the obsolete suckers. Some of the Holothuriæ, as the species just mentioned, bear a resemblance to the Ascidian mollusca. *H. phantapus* has been described by Pennant

* "Hist. Anim.," i. 1 § 8.

under the name of *Ascidia rustica*. All the species have the power of changing their shapes: at one time they elongate themselves like worms; at another time, as in the case of a specimen now before me *H.* (*cucumaria*) *pentactes*, they blow themselves out with water, becoming almost globular, and looking ready to burst. Sometimes they contract the middle of their bodies, so as to "give themselves an hour-glass shape." The colour of these animals varies considerably, not only amongst different species, but amongst different individuals of the same species. In size they differ considerably, varying from three-fourths of an inch in length to a foot or more. Certain foreign species grow to a much larger size. The *Holothuria oceanica* of the Isle of Otaheite, described by Lesson (Fig. 7), attains the size of nearly four feet. The largest British species is the *H.* (*cucumaria*) *frondosa*, first observed by Forbes and Goodsir, in 1839, in the Shetland seas. As a rule, the Holothuriæ in confinement are inactive creatures, and, when their plumose tentacles are withdrawn inside the body, where they will often remain for days together, not very attractive in external appearance. Some kinds, however, are said to be exceedingly active.

(2.) Holothuriæ are found in mud, and amongst sea-weed in the sea around our coasts. Dredging is the most certain mode of capturing specimens, according to my own experience. It is very difficult to secure good specimens, for by forcibly dragging them from their places of attachment they get injured, and seldom remain alive more than a few days; they usually die with the tentacular circlet loosely extended.

According to the late Sir J. G. Dalyell, who paid great attention to the study of these animals—as indeed he did to a great number of the lower forms of animal life—the Holothuriæ show an extreme tendency to rupture: "Such an accident," he says, "whether external or internal, is particularly incident to larger specimens, and slight abrasion of the skin seems to be irremediably fatal. It does not appear that the rupture is confined to any part of the body, though frequently ensuing in the vicinity of the terminal orifice of the great cloaca. A prolapsus then follows, whereby the intestinal organs are discharged in large proportion. Sometimes the rupture is in the side of the animal, not far from the middle, where portions of the ovarium, almost mature, escape. An intestinal protrusion also sometimes ensues by the mouth, with rupture of the body." Those who have kept Holothuriæ in confinement, will bear out Sir John Dalyell's remarks, and all who have dissected the animals will share with him the surprise at seeing

such ruptures in integuments so strong, which are generally so "hard and tough, that an edged instrument can hardly pierce them." Most of the Holothuriæ are extremely susceptible when touched. A naturalist who accompanied Sir Edward Belcher during his voyage in the western seas, mentions a Holothuria with a soft, brown, tesselated integument, which on being touched—suddenly ejected the entire contents of its sacciform body, including the whole of the viscera and appendages—shrivelled up, and died. The reader will here be reminded of an analogous habit of some other Echinodermata which, when touched, immediately throw off their arms, and by a voluntary act of suicide seek to disappoint their would-be captors.*

(3.) We must now glance at the internal structure of these creatures. Some species differ slightly from others in this respect, but the following account, partly the result of my own investigations and partly that of others, may suffice to give a general notion of the internal anatomy of the Holothuria, though it must be confessed the functions of certain organs are not so certainly known as to preclude considerable doubts.

If we place a specimen of *H. pentactes* in a gutta percha trough, and fix it firmly down by two strong pins, one on each side of the collar, or part just under the mouth, and do the same by means of two more pins, one on each side of and a little above the posterior extremity, and then fill the trough with water, and place the specimen under one of Dr. Lawson's admirable dissecting microscopes, we shall be ready for our investigations. After noticing the beautiful circle of tentacles, we cut them off and put them away, in order to get a clearer view of the form and position of the mouth. This, we see, is simply a circular cavity, into which we insert the point of a pair of scissors and cut away—and hard cutting it is—through the tough integument towards the vent. Within the mouth are several white calcareous elongated plates forming a dental circle, which some consider to be analogous to the teeth of Echini. They are, however, very unlike the strong dental apparatus of their distant relatives, and seem incapable of any bruising power. "These plates," as Professor Rymer Jones remarks, "from their extreme friability, have been aptly enough likened to laminæ of dried paste; they may indeed in some slight degree be efficient in bruising food taken into the mouth, but it is more probable that they merely form points of insertion to the longitudinal muscles of the body, which, thus fixed around the circumference of the oral orifice, will

* As in Luidia, Forbes's "British Star-fishes," p. 138.

by their combination powerfully dilate that aperture for the purpose of taking in nourishment."*

Following our course past the dental circle, we come to a membranous tube, the œsophageal portion of the intestinal tract. This we can readily enough make out; the whole tract is nearly the same breadth throughout its entire length, presenting scarcely any appreciable stomachal dilatation; its course is tortuous, descending towards the posterior extremity, and then winding upwards again towards its commencement, again passing backwards and ending in a membranous cavity, the *cloaca*. The walls of the intestinal tract are connected by delicate mesenteric folds to the body. It is thus seen that the digestive apparatus of a Holothuria is of simple form, consisting of one long tortuous membranous tube, which commences close to the mouth, and, after several convolutions, terminates in a wide expansion near the anal extremity. In the intestinal tracts of the specimens I have personally examined, I have found no remains of food; it is said that sand, algæ, with debris of corals, are often found in the intestinal tract. The absence of any effective dental apparatus, and the inability of the tentacular coronet to grasp any prey, would, *a priori*, lead us to suppose that soft inactive animals, as various marine worms of easy digestion, which the Holothuriæ might capture on the mud, entered largely into their diet. The sand might be accounted for in this way, as being the remains of the cases of certain tubicular annelids. Nevertheless, the Holothuriæ have been known to swallow entire shells, for Tiedemann found several in the intestinal canal of *Holothuria tubulosa*, so that the animal matter must be dissolved in the shell and digested, the shells and other indigestible matter being rejected from the cloaca with the water in expiration.

Careful dissection reveals on each side of the body an elegant arborescent organ, commencing at the upper part of the cloaca, near the end of the intestine, by a wide opening, and leading to a membranous tube. This tube runs up towards the anterior extremity of the body, giving off numerous plumose branches. "One division of this elegant apparatus is maintained in close contact with the walls of the body by a series of delicate tendinous bands, while the other becomes applied to the convolutions of the intestines, wherewith it is likewise united. It is this last-mentioned division that would appear to be specially provided for the oxygenation of the nutritive fluids taken up by the intestinal veins." See Plate II. Fig. 7.

* "General Structure," etc., p. 246.

Notwithstanding the careful investigations of Tiedemann and Delle Chiaje, who differ considerably in their interpretations, there still exists much obscurity about the circulation of the blood in these animals, as in the Echinodermata generally. The subject is beset with great difficulty. According to Tiedemann, the nutritive portion of the food is taken from the intestine by the mesenteric veins, and conveyed with the veinous blood of the system by other vessels into the respiratory tree, from whence it is again collected by the bronchial veins, to be distributed through the great systemic arteries.

With regard to the reproductive organs in this family, recent investigators maintain that these animals, and other Echinodermata, are unisexual, and not hermaphrodites. At least, such is the opinion of Wagner, Peters, Müller, and Rathke. The ovary in the Holothuriadæ consists of a mass of long tubular appendages, which hang by their extremities downwards, and open above into a single excretory duct, being fastened to it like a brush. The oviduct, or the efferent vessel, lies along the anterior portion of the intestinal canal, and terminates near the anterior extremity of the body by a distinct opening on the dorsal surface. In the spring time, these long filamentary ovarian tubes become immensely distended with very minute ovules, which are suspended in a whitish, yellowish, or reddish fluid. The development of the Holothuriadæ has been studied by Hrn. Müller,* who has written an elaborate paper on the subject, and given numerous figures showing Holothuriadæ in their different stages. In their earliest stage the larvæ are somewhat flattened, with several ear-shaped lobes, resembling, as has been aptly said, a "coat of arms with its surrounding ornaments;" these young Holothurian larvæ are at first very small —in some species not more than eight-tenths of a line long. They are ciliated, and swim rapidly in a rotary motion, by means of their vibratile cilia. From the body being indented, and forming several ear-shaped lobes, the name *Auricularia* was given to these animals, it being at one time supposed that they constituted a new genus.

Fig. 1, Plate II., represents the second stage of a Holothurian larva, which has now assumed a barrel-shaped form, with five bands of cilia, and showing two calcareous wheels at its lower extremity. A more developed form is seen in Fig. 2, showing

* See his valuable memoir, "Uber die Larven und die Metamorphose der Holothurien und Asterien," in the "Transactions of the Berlin Academy," for 1849. See also an admirable paper by Professor Wyville Thomson "On the Embryology of *Asterocanthion*," in "Quarterly Journal, Microscopic Society," for 1861.

tentacles, calcareous ring surrounding mouth, intestinal tract, etc. A further development is seen in Fig. 4.

(4.) A very remarkable fact in the history of the Holothuriadæ is their power of reproducing lost viscera, to which allusion has been already made. On this subject the late accomplished Prof. Forbes remarks, "Sometimes the creature ejects all its viscera, or bursts the body with its convulsive contractions. It is usually stated that the Holothuriadæ do so whenever they are taken, but such is not the case. I have never seen the animal disgorge its intestines, but specimens of many species have I seen, in which there was not a trace left of the creature's bowels and other internal organs, though it seemed, when taken, alive and healthy. It is astonishing how long they can live deprived of the most essential parts of their organism. Sometimes they are found wanting the respiratory organs, and sometimes the generative tubes are deficient; and these deficiencies so frequently occur, that we should be extremely shy of proclaiming differences in the internal structure of species; and when we see genera and species (as has been the case) *anatomically* defined from the want of respiratory trees or genital tubes, we should be extremely cautious about admitting such, and rather regard such wants as accidental deficiencies in a few specimens than as organic peculiarities." *

At a meeting of the British Association, at Glasgow, in 1840, Sir J. G. Dalyell stated that he had observed certain species of Holothuriæ lose "the tentacula with the cylinder (dental apparatus), mouth, œsophagus, lower intestinal parts, and the ovarium, separating from within, and leaving the body and empty sac behind. Yet the animal does not perish. In three or four months all the lost parts are regenerated, and a new funnel, composed of new branches, as long as the long body of the animal, begins to exhibit the same peculiarities as the old one, though longer time be required to attain perfection. Other species of the Holothuriæ divide spontaneously through the middle into two or more parts, all becoming ultimately perfect by the development of new organs. Yet the anatomical structure of the whole genus is so complex, as to defy the skill of anatomists in discovering the proper functions of some of the parts." †

This voluntary ejectment of the internal organs seems the more surprising when we reflect how seriously even slight internal injuries affect the animals, and causes a prolapsus of their viscera,

* Forbes's "British Star-fishes," p. 199.

† "The Power of the Creator Displayed," vol. i.

which invariably terminates fatally. The voluntary ejectment of the viscera has been noticed by several observers. Of *Thyone papillosa*, Dr. Johnston gives the following account:—"The animal having been kept in sea-water unchanged for two or three days, sickened, and, by the more frequent involutions and evolutions of its oral end, evinced its uneasiness. Being left unobserved in this state for an hour or so, I found on my return that it had vomited up its tentacula, its oral apparatus, its intestinal tube entire, and a large cluster of ovaries which lay about the plate. The muscular convulsion must have been very great, which thus so completely embowelled the creature; and yet life was not extinct, for the tentacula contracted themselves on being touched, and the empty skin appeared by its motions to have lost little of irritability." Lost little of irritability, forsooth! Professor Rymer Jones amusingly remarks—"Had Dr. Johnston only waited long enough, he would have found that the animal was all the better for the gentle depletion; and having got rid of such troublesome trifles as its old viscera, was quite ready to begin the world again with a new set.

> 'The times have been
> That when the brains were out the man would die,
> And there an end!'

Not so, however, with our Holothuriæ. We have at this moment before us, in a jar of spirits of wine, wherein they have been quietly inurned during the last six months, the entire inside of one of these creatures—mouth, tentacles, alimentary canal, respiratory tree, ovarian tubes, and all; and yet, in yonder tank the animal itself, to which they once belonged, is creeping leisurely about his mimic rockery, apparently as well and active as if they still formed an integral part of his economy, and brandishing a new set of tentacula quite as complete as their predecessors."*

The texture of the skin in the Holothuriæ is very hard and tough, and the muscular system well developed. Five pair of muscles run the whole length of the body; they are separated by spaces, in which tranverse circular fibres are found, that cover the entire inner surface of the skin. By means of these longitudinal muscles, which are fixed round the circumference of the oral orifice (dental calcareous plates alluded to above), the body can be shortened and bent, while the transverse fibres contract it transversely, and thus elongate the animal. A microscopic examination of the coriaceous integuments of some of the Holothuriæ reveals the existence of a number of small isolated plates, pierced, like a

* "Aquarian Naturalist," p. 244.

sieve, with numerous holes; these, no doubt, are the representatives in this family of the solid calcareous plates of the Echini and other Echinoderms. Numerous apertures are distributed over the surface of the skin, through which the muscular feet or suckers are protruded. In some species these apertures occur all over the body, in others they are arranged in five series, reminding the observer of the *ambulacra* of an Echinus, and the relationship of that animal to a Holothuria. In the genus *Psolus*, as we have seen, three series of locomotive feet are placed on a flattened disc, upon which, slug-like, the animal creeps. The structure of the ambulacral feet of a Holothuria appears to differ in no essential particular from those of star-fish and Echini; and the mechanism whereby each fleshy foot is protruded and retracted is similar.

Moveable retractile hooks, which probably aid in locomotion and adhesion, occur in the integuments of some species. Some doubt has been expressed as to the presence of a nervous system in the Holothuria. Cuvier thought he could detect "a very attenuated nervous cord around the œsophagus"; but this is denied by Delle Chiaje. A circular nervous cord within the calcareous œsophagal ring, to which, as we have seen, the longitudinal muscles are attached, has been observed by Müller. This is confirmed by an excellent English authority. "In the Holothuria," says Dr. Grant ("Compar. Anat.," p. 184), "where the axis of the body is greatly lengthened, and the animal reclines and moves on one side of the trunk, like the higher classes; where the calcareous shell is wanting, and the muscular system is most distinct and powerful, the nervous system is extensively distributed, and begins to manifest an approach to the helminthoid type. Interior to the osseous apparatus of the mouth is a white nervous ring, around the œsophagus, from which nerves pass outwards to the large ramified tentacula around the mouth, and others extend upwards along the course of the eight [ten] strong longitudinal muscular bands. Fine white filaments are likewise seen passing inwards to the stomach and alimentary apparatus."

(5.) We have already seen certain intimations of the relationship of the Holothuriæ with some of the Echini and star-fish, and although at first sight there might appear to be nothing in common between the spherical sea-urchin, with its envelope of calcareous plates and bristling spines, the common cross-fish (*Uraster rubens*), with its stellate body and rounded rays, and the sea-cucumber, with its flexible cylindrical body, yet close inspection and a little reflection will convince us that all these animals are more or less distantly

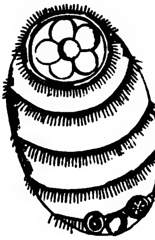


FIG: I.

FIG:2.

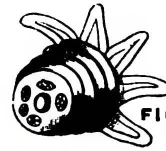


FIG:3

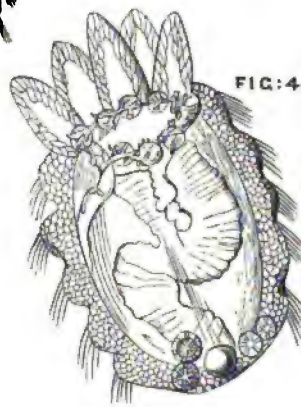


FIG:4.

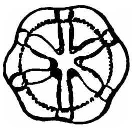


FIG:6.

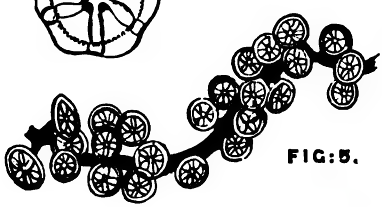


FIG:5.

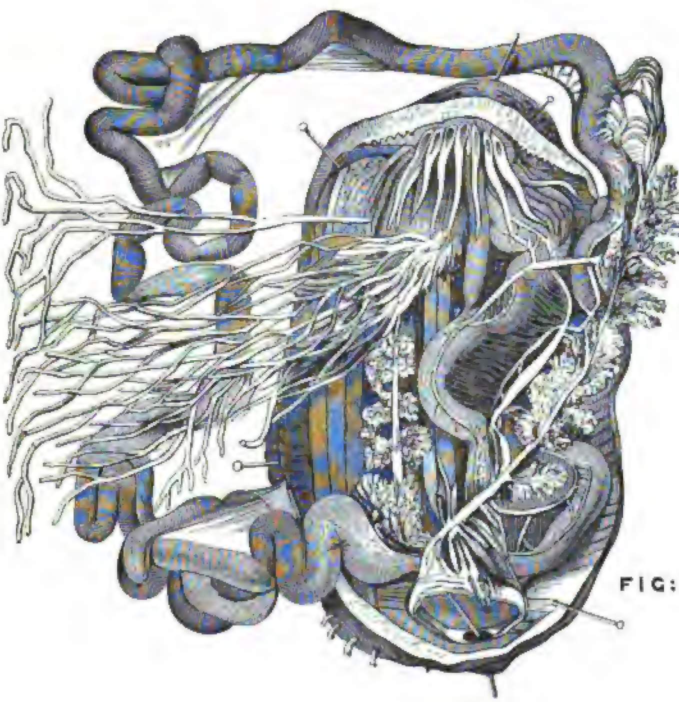


FIG:7.

DESCRIPTION OF PLATE II.

Figs. 1, 2, 3, and 4.—Holothurian larvæ in different stages of development.

Fig. 5.—Calcareous wheel-like plates from the skin of *Chirodota violacea*—a Mediterranean Holothuria.

Fig. 6.—A single "wheel," more highly magnified.

Fig. 7.—A Holothuria opened, showing tentacles withdrawn inside the body, tortuous intestinal tract, long generative tubes, respiratory trees, cloaca, and anus.

related, and are rightly regarded as belonging to the class called Echinodermata by the zoologist. The late excellent Sir John Graham Dalyell could not understand how creatures so apparently dissimilar in external form as a *Holothuria, Asterias,* and *Echinus* could be associated together under the common name of Echinodermata; and yet these different families are certainly allied, as Forbes has well said:—"Throughout animated nature, forms and structures merge into each other, and while the central groups of a type present its essential characteristics, the more distant families approach in appearance and habits to the members of some other great class of forms. This is equally true respecting small as well as large groups. Thus the class of Radiata [Echinodermata] before us presents examples at one extreme of animals truly symmetrical, and at the other of species which approach, either in general form or in their early life, to the Amorphozoa, the lowest of animal types. For example, while the first state of a Comatula is analogous to a sponge or a polypidom, the highest groups of Echinodermata are creatures resembling mollusca or annelida."* Space forbids our dwelling longer on this most interesting subject. Those who wish to appreciate the analogies which link together creatures of very different external form, should read and think carefully over the late Edward Forbes's Monograph of the British Echinodermata, together with Professor Rymer Jones's instructive chapter on the same class, in the first volume of his delightful "Natural History of Animals."†

Forbes divides the British Holothuriadæ into four families, as follows:—

I. Psolidæ, or Ascidian Holothuriadæ, animals approaching the mollusca in their form, and having a soft circumscribed disc, like the foot of a gasteropodous mollusc, on which the suckers are placed for progression.

II. Pentactæ, which have the suckers arranged in five regular rows, and are more or less angular in form.

III. Thyones, which have the suckers scattered all over the surface of the body.

IV. Synaptæ, in which there are no suckers on the body, the oral tentacula being the only representatives of those organs.

The same writer enumerates fifteen British species. Sir John Dalyell has figured and described two kinds not mentioned by Forbes, though he has some doubt as to the claims of *H. Scotica,*

* Forbes's "British Star-fishes," p. xi.

† Ibid, pp. 240—295.

Mr. Peach has given an interesting account of another Holothuria, called the "nigger" or "cotton-spinner" by the Cornish fishermen. The animal, as one of the names implies, is very dark; it is the only British species with twenty tentacula.

"This Holothuria is very common in deep water off the Deadman, in certain localities (rocky ground), and is called by the fishermen a 'nigger,' and at times a 'cotton-spinner;' it is held by them in great detestation, from its throwing out what they call 'cotton,' and from its slimy nature, and also because when the 'niggers' are numerous, and get into the crab-pots, it is very rarely that crabs or lobsters are caught, and therefore they kill all they come near with their knives, because they do not like to touch them. This is not wonderful, for their appearance is anything but prepossessing." We are told that, on being handled, they stain the hand light green, which colour is not easily washed out. Though the colour of the back of this species is generally dark, and almost black at times, yet all shades of colour, from sienna to rose-colour and delicate pink, occur. The tentacula, when viewed from the upper part, are club-shaped on the top, the club being placed on a foot-stalk an inch in length, which is retractile, and invariably of a lighter colour than the top. "When seen from the under side, they appear like the umbels of the elder, and are beautifully branched and tipped, much in the manner of the elder-flowers; indeed they might be mistaken for that flower, only the foot-stalk is so much thicker in proportion." Mr. Peach tells us these 'niggers" eat portions of dead fish, shells, etc. "I have reasons," he adds, "for believing Terebella. He found also in their intestines a *Buccinum incrassatum*, with portions of the animal in it, portions of Balani, Nullipora, etc." This Holothuria "is extremely irritable, and on being touched or disturbed, throws out a bunch of white tapered threads about an inch in length and one-eighth in thickness. These soon become attenuated, either by the agitation of the water or the coming into contact with something, and are drawn into very long threads of great tenacity; they stick to everything they touch. This small bunch is drawn into a large mass of threads, so small that the finest sewing-cotton is not equal to it, and is no doubt one of the means of defence provided for its preservation; for I have seen a crab so completely entangled in it as not to be able to move, and a fish only able to get away after a long struggle. If much irritated, they throw out the whole of their intestines. This is invariably the case after being kept in confinement two or three days; and even after they have done so they have lived three

days, and their tentacula performed all their offices, as if the animal was strong and healthy."*

Figs. 4, 5, 6, 7, Plate I., represent certain foreign Holothurids as drawn on a reduced scale from the plates in M. Lesson's "Centurie Zoologique." *Holothuria oceanica* (Fig. 7) was found by Lesson occurring abundantly in Mattaway Bay, Otaheite, in 1823. It can elongate itself to three feet, and contract to twelve or fifteen inches. An acrid and corrosive liquid lubricates the exterior surface, and produces intolerable itching, so that it must be handled with great caution; the South Sea natives show a manifest repugnance at its sight.†

(6.) The animal depicted (Fig. 4), is the edible Holothuria (*H. edulis*) or "trepang," Biche de Mer, long celebrated in Indian commerce, and still an article of extensive commercial value in some parts of the East, as amongst the natives of the isles of the Indian archipelago, Cochin China, and the Australian islands. Thousands of Malay junks, M. Lesson tells us, are fitted out each year to fish for this animal; the produce is taken to Canton, and sold, at an average, for about forty-five Spanish dollars per picul (= 133½ lbs.). Macassar is the great market for them, and it is said that about 8,330 cwt. are annually exported from thence to China. As many as thirty varieties are said to be distinguished in the Canton market, each variety being designated by different names. According to Mr. Crawfurd, the trepang is sometimes two feet long, and from seven to eight inches in circumference, but its ordinary size is about a span long and two or three inches in girth.

The quality and value do not depend on its size, but upon properties not discernible by those who have not had much experience in the trade. M. Lesson gives the following description of the form of the *Holothuria edulis*. "The *H. trepang* is cylindrical and slender, and about eight inches long. The surface of the body is slightly rugose, body undulating, covered with short scattered papillæ, without definite arrangement; the upper part of the body is of a dark smoky black, the lower part and sides of a pretty rose-colour, speckled with black specs. The mouth is oval, and surrounded by six or eight bundles of rounded floccose tentacles."

* See "Annals and Mag. of Nat. Hist." vol. xv., 1845, p. 171, with Plate.

† Fig. 3 (Plate I.) represents a specimen of *H. fusus* which, in the possession of Sir J. G. Dalyell, had regenerated its lost tentacula. Both *H. fusus* and *H. Scotica* are, I suspect, doubtful species. The figures are drawn on a reduced scale from Sir J. E. Dalyell's "Power of Creator Displayed."

M. Lesson states that he has often eaten these creatures, variously prepared, but never found in them any particular taste, disguised as they always were by the enormous quantities of spices and aromatics in which the cookery of the people abound. I may add, that a relative of mine, when in China, frequently partook of trepang, or sea-slug porridge. He thought the dish by no means a bad one." "On placing one of these curious creatures in a basin," says Sir E. Tennent ("Ceylon," ii. p. 557, note), "it discharged the contents of its stomach; first, streams of water, and then quantities of sand, small stones, and comminuted coral and shells, until it was reduced to a flaccid mass—again inflating itself to its original size by re-imbibing the water." Sir E. Tennent then quotes Mr. Brodie, who, speaking of the trepang, says that the Holothurias are picked up at ebb tide, and after being embowelled are boiled for two hours till quite soft, and then dried in the sun. The price on the spot is about three shillings and ninepence for 1000, and this quantity can be easily collected by two men during one ebb tide. Other species of Holothuriæ are used as food. The *Holothuria tubulosa*, Blainv., is eaten at Naples, and the *H. guamensis* by the Ladrone islanders.

A FUNGUS IN TEAK.

BY HENRY J. SLACK, F.G.S., SEC. R.M.S.

Some weeks ago, Mr. Charles Tyler, was kind enough to bring me a small piece of teak, damaged in a singular way. The main substance of the wood was of a deep rich brown tint, like that of burnt sienna, and did not appear to have suffered general injury, but it exhibited numerous white patches of a cottony aspect, in which the fibre had been more or less completely destroyed, and small cavities lined with cottony-looking threads. Upon examination as an opaque object with a two-thirds objective, the white patches appeared to consist of bleached woody fibre, and seemed quite continuous with sound fibres in which no particular change could be discerned. The cavities seemed to have resulted from the destruction of the fibre. Very little more information was gained by investigation with a half inch and a lieberkuhn. It still seemed as if the white patches had no connection with each other, and no fungoid threads could be discerned. The white fibres were so soft as to break with a touch, and a small portion was removed

with the point of a knife, placed in a drop of water covered with very thin glass, and examined with Beck's one-twentieth objective, the illumination being carefully managed with Ross's four-tenths condenser and 20° stop.

Immediately one of the projecting threads of very minute size gave indications of fungoid structure, and prolonged examinations extending over several evenings led to the result that in every case of examination with this power, and Ross's A and B eye-pieces, extremely delicate threads, more or less beaded in structure, could be distinctly made out, and discriminated from the cellular tissue of the wood.

Being desirous of getting further information on the matter, I applied to Mr. Carruthers of the Botanical department of the British Museum, from whom Mr. Tyler had received his specimen. Mr. Carruthers was kind enough to give me a lárger piece, and likewise a piece of Scotch birch, coloured green, like the "green oak" of the Tonbridge Wells ware, with the fungus which used to be known as *Peziza œruginosa*, but which fungologists now call *Helotium œruginosum*, and is described under that head in Mr. Berkeley's "Fungology." Mr. Carruthers told me that he had examined the wood with one-fifth objective and ordinary illumination, and had not detected any fungoid growth, at which I was not surprised, as the power he employed was insufficient to do more than indicate a *possibility* of such a growth in some places. He also informed me that Mr. Berkeley had written on the subject in the "Gardener's Chronicle," and that he received the wood from Mr. Brisbane Neill.

On referring to the "Gardener's Chronicle" (1st Feb.), I found that Mr. Berkeley had been informed—misinformed as it turned out—that the wood had been soaked with sulphate of zinc, and laid down as a sleeper on an Indian railroad. Mr. Berkeley had not found the "slightest trace of fungus," but said the wood reminded him of "the curious decomposed fossil wood which occurs in Tasmania;" and he referred to an analogous case recorded in Sowerby's "English Fungi" (tab. 387, Fig. 10), where a specimen of similarly damaged deal is figured.

My next proceeding was to request information from Mr. Brisbane Neill, who kindly and promptly replied to my inquiries. This gentleman received the wood from Captain Mitchell, superintendent of the Government Museum at Madras. Captain Mitchell had previously mentioned some damaged teak which had been soaked in a zinc solution, and had been *intended* for a railroad sleeper; and when specimens of damaged teak arrived, it was

at first supposed that this description applied to them. Hence the error into which Mr. Carruthers and Mr. Berkeley had been led. In a subsequent letter to Mr. Brisbane Neill, Captain Mitchell, said, "The wood I sent is not the saturated wood, but is exactly in the state in which it was when cut down, and the whole tree was in the same state. The piece of wood was sent to me by the forest department to whom the tree belonged."

Furnished with this information, I made numerous observations on the damaged fibre in the specimen I received from Mr. Carruthers, and found mounting small portions in glycerine jelly was the best plan for minute examination. Fig. 1, A, represents a vertical and *radial* section of the wood, made by splitting it. The white matter and cavities appear irregular in form and direction. Fig. 1, B, represents a vertical and *tangential* section.* In this the white patches and cavities are seen to be nearly regular in shape, though not in size, and to conform to the curved lines taken by the fibre. Frequently the cavities have invaded vessels and medullary cells.

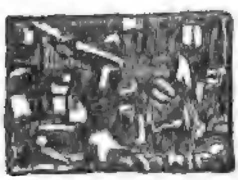


Fig. 1, A.

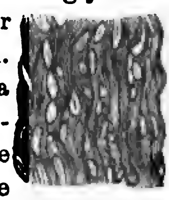


Fig. 1, B.

Turning special attention to the white fibres, I succeeded in many cases in detaching unmistakable though very slender fungoid threads, and examined them with the one-twentieth and A and B eye-pieces, powers about 1000 and 1400 linear. In a few instances, several rounded cells with minute dotted contents were likewise visible.

In removing the damaged fibre and exposing it to some pressure in a fluid under glass, for the purpose of examination, the original position of fine mycelium threads would of necessity be more or less disturbed, but I think their general distribution is in slightly meandering lines. The white patches of germinal matter (?) common in mycelium threads were sometimes irregularly scattered through the thin tubes, and at others collected together in bacterium-like forms. Specimens of this last are shown in Figs. 2 and 3, the latter being unusually large.

Fig. 2.

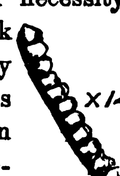


Fig. 3.

* A radial section shows the silver grain of wood occasioned by the medullary fibres crossing the perpendicular fibres of the wood. A tangential section cuts through the medullary cells, and they appear as in Fig. 4.

Thin sections of the wood made with Topping's machine (as made by Baker), were compared with fresh cut sections of sound teak from Bombay.

The damaged teak in thin slices is an extremely beautiful object, especially in those (tangential) vertical sections which show the groups of medullary cells thrust in between the ordinary fibres. The medullary cells are of an exceedingly rich colour, varying from a bright reddish brown to a deep red brown, verging upon black. The dotted vessels are mostly pale brown, and in some of the pits (apertures) a very minute dotted bacterium-looking structure can be seen. The longitudinal fibres between the medullary cells and dotted vessels are paler than in the sound teak, but there may be nothing in this, as different trees may vary in this respect, and in the intensity of the colouring matter in the medullary cells. This contrast between the white damaged portions of fibre, and the adjacent apparently sound portions, is less striking in thin sections than in the mass, and more or less decided indications of mycelium threads of slender diameter, may be seen throughout some slices with a one-fifth and C and D eye-pieces, and careful illumination. The fungoid threads are very much smaller than those in the piece of birch already alluded to, stained green by the *Helotium æruginosum.*

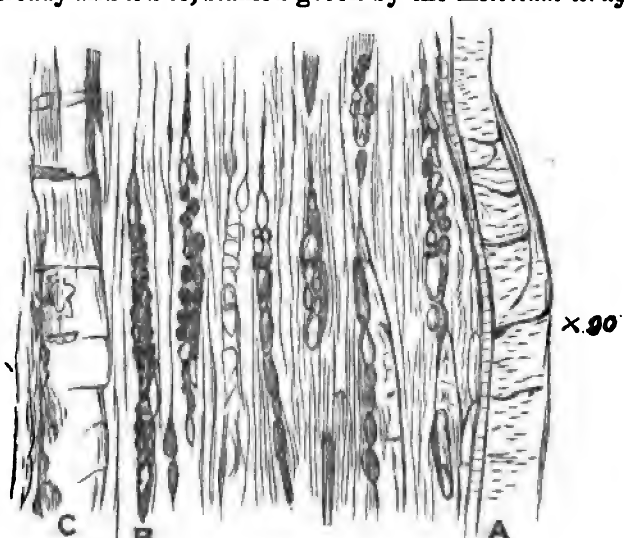


Fig. 4.—Section of damaged teak. (See description at the end of this paper.)

In one case, by splitting a piece of the wood in a vertical and tangential direction, I succeeded in tracing a good many white fibres, establishing a connection between what at first appeared

isolated cavities and white patches. These white fibres were not distinguishable from those in the cavities. They were wood fibres with (I suppose) mycelium threads accompanying them, similar to those detected in the cavities and white patches.

Mr. Berkeley on receiving a note from me, re-examined his specimen, and found "a few extremely delicate threads," not sufficient to account for the injury, and he remarked on the improbability of fungoid threads doing the damage in isolated spots, and not even changing the colour of neighbouring tissues.

I attribute my greater success in discovering fungoid threads, simply to my having used a one-twentieth instead of only one-fifth objective, and having perhaps had an advantage with Ross's condenser. My belief is that the neighbouring tissues are not entirely unaffected, but that the fungoid threads have permeated the wood in various directions forming more developed groups in patches where perhaps the woody structure gave them greater facilities for growth. I have often seen similar threads amongst submerged moulds and mildews, and met with them repeatedly in investigating the vinegar plant, in various conditions and stages of growth. Whether such threads can belong to the mycelium of such a fungus as the Helotium, or any of its relations, I must leave an authority like Mr. Berkeley to decide.

That the injury done by bundles of minute fungoid threads should be great, no one who has noticed the oxydizing power of certain extremely slender forms of vegetation can doubt, and when a portion of a tree is in decay, it is far more likely that living organisms of some kind have something to do with its destruction than that it is a purely chemical action, as must, in the case of this teak, be supposed, if the fungoid threads I have succeeded in showing are not considered the agents of the change.

Mr. Berkeley very kindly sent me a small portion of the damaged deal referred to by Mr. Sowerby. The fibre seemed less damaged than in the teak case, and though mycelium threads were discernible, it was almost impossible to distinguish them from slight wrinkles, or folds in the woody tissue. So far as I could identify any objects as mycelium threads, they seemed larger than in the teak, and with less dispositon to take a beaded form. A piece of white wood in the condition known as "touchwood," also sent by Mr. Berkeley, gave similar results.

EXPLANATION OF WOODCUTS.

Fig. 1, A and B.—Portion of the teak. The white spots being

the damaged and bleached places. N.S. A, radial; B, longitudinal section.

Fig. 2.—Beaded threads lying on woody fibres. Mag. 1400.

Fig. 3.—Larger beaded thread. Mag. 1400.

Fig. 4.—Vertical (tangential) section of damaged teak. A, dotted vessel; C, ditto, partially broken; B, medullary cells. Mag. 90.

ASTRONOMICAL NOTES FOR APRIL.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

THE only planets suitable for evening observation during this month will be Venus and Saturn.

VENUS will be gibbous throughout the month. Each evening she will increase in apparent brilliancy, and be visible for a longer time; setting on the first day at 10h. 43m., and on the last day not until 11h. 46m. Her place in the heavens changing from R.A. 3h. 26m., N.P.D. 69° 19′, to R.A. 5h. 46m., N.P.D. 63° 24′, she will be always in the constellation Taurus, passing on the third day 2° or 3° to the south of the Pleiades, and on the 25th, about the same distance to the south of the bright star β Tauri. On the 26th she will be in conjunction with the Moon at half-past seven o'clock in the morning, and will therefore, early in the evening of that day, be conspicuous near the crescent, then but three days old.

SATURN becomes now well observable in the evenings. On the first day of the month he rises at 11h. 12m., and on the 30th as early as 9h. 10m. His path in the heavens will carry him during the month from very near ψ Ophiuchi, a star of the fifth magnitude, to about half-way between that star and ν Scorpii, a close double star, the components of which are of the fourth and seventh magnitudes. On the 10th he will be in conjunction with the Moon about seven o'clock in the evening, being then about 3° to the south of her.

Saturn's rings are this year very favourably situated for observation. The minor axis of the exterior ring exceeds in apparent breadth the diameter of the planet. A very good opportunity is therefore afforded for the study of those interesting appendages, the discovery of which was one of the first-fruits of the invention of the

telescope. Galileo indeed imagined that the planet was as it were threefold, having a smaller body on each side adhering to it; but Huyghens, in the year 1656, announced that the cause of the appearance was that the planet was "surrounded by a slender flat ring, everywhere distinct from the surface, and inclined to the ecliptic." This ring is now known to consist of several divisions; but particularly of three well-marked ones—a narrow exterior ring, called A; a broader and somewhat brighter next within, denominated B; and still within this a dusky semi-transparent ring, called C, which has been likened to a crape veil, and permits a faint view of the covered part of the ball of Saturn to be seen through it. This last has been much more recently discovered than the others. On the 25th of November, 1850, Mr. Dawes (whose death we have so recently to deplore) was, to use his own words,* "astonished at the appearance of a faint light extending over rather more than one-third of the interval between the inner edge of the bright ring and the ball." On November 29th the same phenomenon was observed. "There appeared to be a continuation of the breadth of the ring towards the ball, extremely faint, as if capable of reflecting very little light. A dark and rather sudden shading off was observed to form a boundary between this dull zone and the bright ring, the breadth of the zone being about two-thirds the breadth of the outer ring. At the interior edge of the ring, where it crosses the ball, a very narrow dark line was noticed, which became broader towards the east and west edges of the planet. I concluded that this dark line was the projection of the obscure zone, the full breadth of which is seen at the ansæ." Mr. Lassell, being on a visit to Mr. Dawes on December 3rd, saw, on the evening of that day, the same thing. The day after, they saw the announcement that Bond, at Cambridge, Massachusetts, had discovered an interior very faint ring of Saturn, and Dawes at once expressed his conviction that that view of the appearance was correct. It will, perhaps, be interesting to quote also the original observations of the Messrs. Bond concerning this discovery, as given by the father, W. C. Bond, at that time director of the Harvard College Observatory.† "The first diagram of the new interior ring of Saturn was made by G. P. Bond, on the night of the 11th of November, 1850. The memorandum in the note-book runs thus:—Nov. 11, 7h. 30m. We notice to-night with full certainty the filling up of light inside the inner edge of the inner ring of Saturn; also, what is very singular,

* "Astronomische Nachrichten," No. 751.

† Gould's "Astronomical Journal," vol. ii., p. 5.

where the ring crosses the ball, *below* the edge, there is a dark band, no doubt the shadow of the ring. But there is also a *dark line above* the ring very plainly to be seen, as there can be no question of the line where the ring crosses the ball. The light which fills the corners of the inner ring is suddenly terminated on the side towards the ball. The light does not arise, I think, from any optical cause, for I cannot see why the same appearance should not be visible on the outside of the ring, or indeed of any object which we look at. Am very confident of having seen to-night a second division of the ring near the inner edge of the inner ring." They again observed the new ring on November 15, and W. C. Bond thought he saw it clear of a connection with the old, but the side next the old not so definite as next the planet. The same evening (the definitions being remarkably good), G. P. Bond wrote, "Cannot be sure that the new ring is divided from the old one, but there can be no doubt that it exists. I did once or twice fancy, with the higher powers, that there was a division between the old and new rings."

When Dr. Galle, of Berlin, had seen these announcements, he* called attention to the fact that he had himself published, as early as the year 1838, some observations of an appearance like that of a veil (Schleier) adhering to the interior ring, and occupying half the space between that and the ball of the planet, which he, however, considered not as a separate ring, but as an extension of the interior ring. As he gave some very accurate measures of this appearance, he is generally thought entitled to being considered the first discoverer of the dusky ring, as it is now acknowledged to be. Search through ancient records has since shown that, many years before, appearances were noticed by several observers which must have been produced by the newly-discovered appendage. The first of these observations appears to have been made by Hadley in the year 1720.†

We must refer also to some very interesting observations of the dusky ring made by Mr. Lassell at Malta in the year 1852.‡ "One of the most striking attendant phenomena which I now note for the first time, is the *evident transparency of the obscure ring.* It is of a much lighter texture than the other parts, and both limbs of the planet can readily be traced through it. . . . . Notwithstanding the exquisite views I have had of the planet since my arrival here, far exceeding in sharpness of definition all I have ever

* "Astr. Nach.," No. 756.
† "Phil. Trans.," 1723.
‡ "Monthly Notices of the R.A.S.," vol. xiii., pp. 12, 13.

seen at Starfield, I have never obtained a single glimpse of the division in the ring C, seen and measured micrometrically by M. Otto Struve, nor of the ring being concentrally divided into two, as seen by Mr. Dawes. On every occasion, and when most sharply defined, it appears of one uniform texture and depth of shade, constantly conveying to my mind the idea of network on a crape veil, as I originally described it."

A curious observation by Mr. Carpenter, of the Royal Observatory, Greenwich, may be noticed here. It was made on the evening of March 26, 1863, and consisted in a "great increase of brightness of the dusky ring, which appeared nearly as bright as the illuminated ring, and might easily have been mistaken for a part of it."

The boundaries, changes, division, and amount of transparency of the dusky ring, also the division of the exterior bright ring, are matters calling for further examination by those observers who are provided with good instrumental means. With regard to the rings generally, Sir John Herschel remarks that all indications from observation point to a vaporous constitution. Physical considerations also make this probable, and "it is very possible that the rings may be gaseous, or rather such a mixture of gas and vapour as consists with our ideas of a cloud."*

Occultations of Stars by the Moon.—Only one of these is visible in the evening, that of k Virginis, a star of the 6th magnitude, on the 6th day of the month. Disappearance, 10h. 35m.; reappearance, 11h. 30m.; angular distance from the vertex to the right hand in inverting telescope, 9° and 281° respectively. Whilst this star is behind the Moon, another of nearly equal (6½) magnitude, 46 Virginis, will just escape occultation on the other side of the Moon, her limb passing, about 11h. 10m., within a very short distance of it.

The Moon.—The phases of the Moon, with notices of those regions of her surface, which will be at different times under or near the terminator, we have this month thrown into a tabular form. No new feature of particular interest has, so far as we know, been brought to light since the date of our last "Notes."

April 1. Plato, Eratosthenes, Mare Nubium.
„ 2. Mare Imbrium, Copernicus, Bullialdus.
„ 4. Kepler, Gassendi, Mare Humorum.
„ 5. Aristarchus, Galileo, Schickard.
„ 6. Grimaldi.
„ 7. Full Moon at 7h. 17m. A.M.

* "Outlines," § 518.

April 8, 9. Mare Crisium, Mare Fœcunditatis.
„ 14. Last Quarter at 10h. 35m. P.M.
„ 22. New Moon at 8h. 20m. P.M.
„ 25, 26. Mare Crisium, Mare Fœcunditatis.
„ 27. Posidonius, Mare Tranquillitatis, Theophilus.
„ 28. Mare Serenitatis, Maurolycus.
„ 29. First Quarter at 6h. 18m. P.M. Archimedes, Hipparchus.
„ 30. Mare Nubium.

APRIL METEORS.—An interesting group of meteors has established a claim to consideration for this month. Not long after the remarkable fact was proved, that the August and November groups move in orbits nearly coincident with those of two small comets, it was noticed, by Drs. Weiss and Galle, that the April meteors also followed nearly the path of a comet, known as I. 1861, which was discovered by Mr. Thatcher, of New York, and is supposed to have a period of 415 years.* But as the observations of that group were not very numerous, it was desirable to procure, if possible, some confirmation of this.

Last year, however, little additional information was obtained. Indeed, the only observations we have met with were made by Professor Karlinski, of Cracow, who saw nineteen meteors, chiefly of the first or second magnitude, between midnight on April 20, and three o'clock on the following morning. Of the nineteen, sixteen appeared to belong to the group, and they gave a radiant point, agreeing well with the observations of former years, at about R.A., 18h. 0m., N.P.D., 55½°, or very near the constellation Lyra. If we assume that the earth crossed the orbit of the meteors last year about two o'clock Cracow, or one o'clock Greenwich, time, on the morning of April 21, it will follow that we shall this year cross it about seven o'clock on the morning of April 20. This may be somewhat in error, and it will be advisable to keep up a watch for a few hours before daylight on that morning, in the hope of observing a few meteors of the group, and improving our knowledge of its orbit.

THE NEBULA OF ORION.—An interesting paper by Professor D'Arrest has recently appeared in the "Astronomische Nachrichten," on the great nebula of Orion, which it seems desirable to give some account of here. He states that in the disputed question as to changes which have been said to have taken place in the

* See a paper by myself in the "Proceedings of the Meteorological Society," for 1867, April.

appearance of the nebula, a drawing made by Lefebvre, Professor of Physics at Lyons, in the year 1783, and published at Paris in the 22nd volume of "Rozier's Observations," has been overlooked. An examination of it throws doubt upon several of the supposed changes, as it delineates the parts of the nebula to which they refer in a manner very similar to that of the latest drawings of Bond and Struve. So that the variability would appear to be limited to some temporary changes of light at some nodal points, and the greater or less visibility of the faint patches of light which fill up some gaps, such as the Sinus Lamontii. The question of these changes has become of great interest since Mr. Huggins's prismatic analysis of the nebula has shown that it possesses a gaseous constitution. The variability of the faint stars within the trapezium appears to be well established. But further observation of the light of different parts of the nebula itself are very desirable. D'Arrest gives in the same paper some observations made by him of the branches of nebulous matter which connect the great nebula about θ Orionis with the smaller masses on each side of it, about ι and c Orionis. Thus θ and ι are connected by a double branch, and θ and c by a threefold branch. The system evidently extends still farther. But the examination of these minute points is very laborious, and can only be pursued on very favourable nights, and with very powerful object-glasses. Some of the branches mentioned were observed also by G. P. Bond, but were not figured by him, owing to his death shortly afterwards, which, it will be remembered, took place early in 1865, before he could receive the medal of our Astronomical Society, which had been that year awarded to him, in recognition of his important observations and discoveries.

THE NACHET ROTATING STAGE FOR THE MICROSCOPE.

At one of the meetings of the Royal Microscopical Society last year, Dr. Carpenter exhibited a binocular microscope, by Nachet, fitted with a rotating stage, which he highly commended. Acting upon Dr. Carpenter's advice, Mr. Henry Crouch (of London Wall), adapted this form of stage, with a slight improvement in its construction, to the instrument which he calls his "Cheap Binocular."

The Nachet rotating stage is very similar to the excellent pattern which the late Richard Beck—to whom microscopy was so

deeply indebted—constructed for his well-known "Popular Microscope," but it differs in some particulars. The accompanying sketch will render its construction and action intelligible. C is a plate of thick black glass, set in a brass circular frame, with a milled edge. A slight pressure upon the milled edge causes the

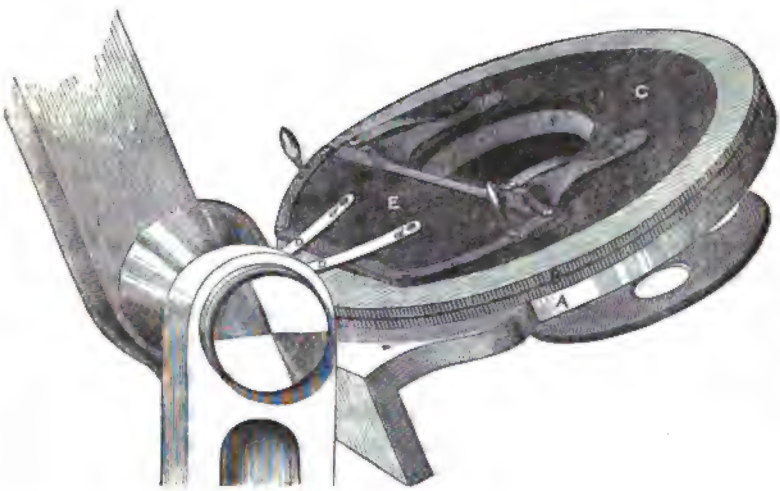


plate and object to rotate very smoothly and concentrically with the optic axis of the instrument. The object-holder is formed of another piece of smooth polished black glass, (E), carrying a brass frame on which the object is laid. Two brass springs, *d d*, with smooth ivory points at their extremities, press the glass plate, E, against the stage plate, C, with sufficient force to keep it steady when carrying ordinary objects or apparatus. The two upright brass handles enable the plate, E, to be slided in any direction with a very equable and agreeable motion, and with sufficient adhesive resistance to ensure steadiness. The extent of motion is determined by the brass frame of the plate, E; the motion stops as soon as the ivory points come into contact with the frame in any direction. The amount of motion is abundant for slides, etc., but is not quite enough when zoophyte-troughs are used. While, therefore, thoroughly agreeing with Dr. Carpenter in estimating very highly the convenience of this kind of stage, we have suggested to Mr. Crouch the propriety of adding a trough-holder, which will very slightly increase its expense.

We congratulate Mr. Crouch upon having now produced one of the most complete and scientifically constructed of the cheap microscopes. He has done well in adapting it on Beck's plan to

carry all the illuminating apparatus usually required, and in providing it with the universal screw.

Ross's new instruments and apparatus fit the same guage as Beck's. Crouch wisely takes the same sizes, and we hope soon to have an universal guage for apparatus as well as for the screws attached to powers.

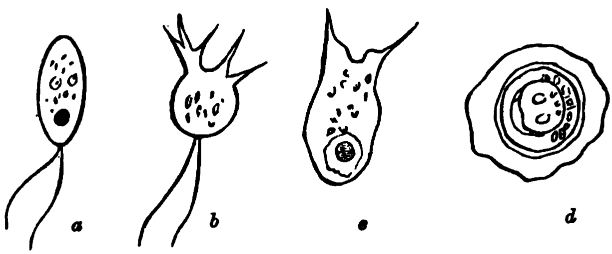
NOTES FROM PROFESSOR HUXLEY'S LECTURES AT THE COLLEGE OF SURGEONS.

BY E. RAY LANKESTER.

We have heard some persons ask, "What is the good of attending lectures? Cannot you learn everything you will hear much more effectively by reading at home?" In very many cases, no doubt, it is true that lectures are not what they should be; but such lectures as those which a master in science can give are worth many books. It is because Professor Huxley possesses two great qualifications that his lectures are now so numerously attended, and so deservedly esteemed: he is a most original thinker and brilliant observer, and perhaps what is more important, he keeps himself thoroughly acquainted with the work done in his departments of science in Germany, France, and elsewhere, and thus is able to give in his lectures the latest results of thought. It would be impossible, in a brief space to give a report of the lectures which Professor Huxley has delivered this spring at the College of Surgeons on the Invertebrata, but we may notice a few points of novelty or interest which have been discussed. The Invertebrata are regarded by Professor Huxley as very sharply cut off from the Vertebrata. There are no links which connect the two in any way; the bi-cavitary structure and the notochord of the Vertebrata is not approached by any member of the other groups of the animal kingdom. At the same time, the Invertebrata do not form an assemblage equivalent in value to the Vertebrata, but contain many such assemblages. On the other hand, when we examine the lowest members of the Invertebrata where they approach the kingdom of plants, we find no such sharp line; in fact, it seems impossible to erect a definite boundary. The points which separate undoubted plants and animals, are sufficiently numerous. The plant has a cellulose investment to its cell, does not exhibit locomotive * or con-

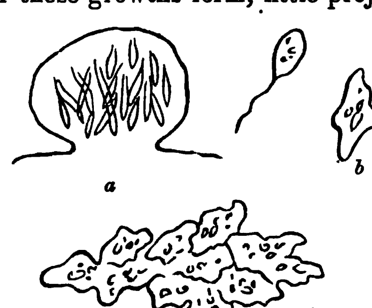
* Professor Huxley must have spoken these words unadvisedly, as the motile zoospores of undoubted plants abundantly show.—Ed.

tractile organs, and never takes solid nutriment; and plants alone can form vital matter from mineral forms of carbon, hydrogen, oxygen, and nitrogen. Animals are in all these matters the reverse of plants. But amongst the doubtful forms we find organisms agreeing in some things with plants and in others with animals. Cienkowski has recently (1865) been studying the Monads; those minute animals with a vibratile filament at one or both ends of their bodies, so common amongst decaying organic matters. Professor Cienkowski shows that these organisms pass through an animal and a vegetable condition. A Monad such as *a* (*Pseudospora*) passes



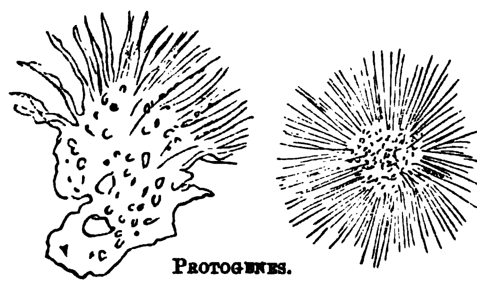
into the Amœba-form, *c*, through *b*, losing its flagellum; then, after feeding as an Amœba, and creeping about for some time, it assumes the encysted form, *d*, becoming invested with a *cellulose* sheath, and often acquiring a chlorophyl or plant-green colour. This form, *d*, after some time splits up into four or more parts, each of which becomes such a Monad as *a*.

The form called Myxomycetes presents another example of dubious nature. These growths are found on the surface of tan-pits, and on old trees and wood generally. They have very generally been set down as "fungi," but their investigation by de Bary shows that this view cannot be unhesitatingly taken. On the surface of the slimy masses which these growths form, little projections like minute puff-balls appear, and become filled with spores, *a*. These spores being set free by the bursting of their capsule, give rise to innumerable Monads, and these again to Amœba-forms, *b*, which for some time lead an animal existence; but presently, if they fall in a suitable



nidus, numbers of these Amœbæ aggregate, and fuse into masses, *c*, as large as your hand, in which state they form incrusta-

tions, and actually move *en masse* (as in *Œthalium*). It is from these incrusting masses that the puff-ball-like capsules arise, developing from the *plasmodium* as the viscid substance has been termed. Though in their Amœba-condition, these organisms have been observed to take in solid food, Professor Huxley thinks that the mode of reproduction places them decisively amongst plants. A third case, which is perhaps more puzzling than any, from its absolutely negative character, is the organism called by Professor Haeckel *Protogenes* (1865). This is simply a minute drop of living jelly, far simpler than even a white blood-corpuscle, having no nucleus, no contractile vesicle, "no nothing," in fact, except the property of flowing in various directions, and of protruding innumerable fine



PROTOGENES.

processes or pseudopodia, which are very efficient in seizing and engulfing anything nutritious, the act of deglutition consisting, as in the Amœba, of a pouring of itself over its food on the part of the *Protogenes*. Professor Huxley remarked upon the blow that this discovery gave to the speculations of cell-theorists, and even to views of the mysterious power of nuclei. Here is a living being absolutely devoid of structure, that is to say of any structure excepting molecular structure. Its existence proves life to be a molecular property, and that organization is the product of life, not life the product of organization.

Professor Haeckel, of Jena, in a very remarkable work, the "Morphology of the Organism," published a year since, has proposed a sort of no-man's land, neither plants nor animals, for the dubious forms. He calls them Protista, and gives the following groups: 1. Moneres (*Protogenes*, etc.); 2. Protoplasta; 3. Diatomea; 4. Flagellata (*Monads*, *Euglenæ*, *Volvox*, etc.); 5. Myxomycetes; 6. Noctiluca; 7. Rhizopoda; 8. Spongiada. Professor Huxley does not approve of this plan at all, as a new difficulty of definition is added by the new kingdom. He would place the Diatomea with plants, as also the Flagellata and Myxomycetes. Noctiluca is undoubtedly a highly-organized animal, whilst the Protoplasta, Rhizopoda, and Spongiada are animals, and with them goes Protogenes, though this gives, if any organism does, an intermediate and debateable ground.

PROTOZOA.

1. Moneroza—
   α. Protogenes, β. Foraminifera, γ. Amœboidea, δ. Gregarinida.
2. Radiolaria—
   α. Thalassicollæ, β. Polycistina.
3. Spongiada—
   α. Halisarcidæ, β. Clionidæ, γ. Spongidæ, δ. Petrospongidæ, ε. Tethyadæ.

The above are the groups and arrangement which Professor Huxley now adopts in the Protozoa, but he considers them very transient and unsatisfactory assemblages. In speaking of the classification of the Invertebrata generally, three distinct sorts of classification were pointed out as possible, a logical, a gradational, and a genetic; the last is the only resting point for our efforts at natural classification. The following scheme was exhibited as a gradational arrangement of Invertebrata—not necessarily involving the hypothesis of genetic relationship as explanation, but simply and truly indicating bare fact:—

Arthropoda — Mollusca
Annulata — Molluscoida
Annuloida — Cœlenterata
Infusoria
Radiolaria — Spongida.
Monerozoa.

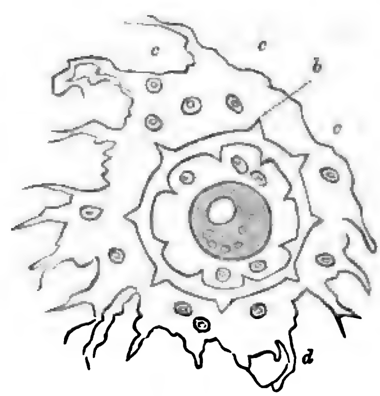
The Foraminifera (a group of Monerozoa) were discussed at considerable length; they were described as little more complex than Protogenes, but capable of forming either a horny, a calcareous, or a built-up shell, in some forms quite simple, but in others, by aggregation of simple chambers, forming most complex structures. There appears to be no possibility of distinguishing species or even genera in Foraminifera, so complete are the gradations of form; only a few "types" can be pointed out. Professor Huxley expressed his belief in *Eozoon*, which he compared with the recent encrusting genus *Carpenteria*.

The Amœbæ (whose general character all microscopists know) multiply by fission, and present an *approach* to sexual multiplication. An Amœbæ becomes quiescent, perhaps encysted, when its nucleus splits into several pieces, each of which, being surrounded by a little

of the parent Amœba's sarcode, is set free as a new and very small Amœba. Professor Huxley doubts if the contractile vesicle has a permanent opening in these creatures.

The encystation and formation of pseudo-naviculæ in *Gregarinæ* resembles the process in Amœba; but as there are often two *Gregarinæ* in one cyst, it presents analogies to the conjugation of Algæ. The *Gregarinæ* have no pseudopodia and no sac or cuticle, the cortical substance is simply denser than the deeper matter which contains the granules.

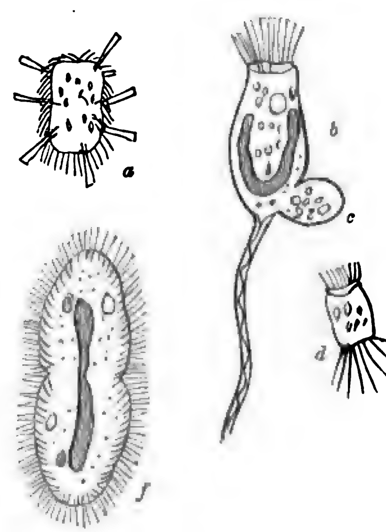
The *Radiolaria* are known to microscopists in England by the beautiful siliceous shells of Polycistina from Barbadoes. The Polycistina are the simple, the Thalassicolæ the compound or aggregated forms. The fresh-water *Actinophrys* or sun-animalcule perhaps connects these to the Foraminifera. Ernst Haeckel, in 1362, published a most beautiful work on the group, in which he showed what their characteristic structure was. A mass of sarcode-substance capable of extruding pseudopodia, *d*, contains in its centre a sac, *b*, this sac has a nucleus and granules within, and sometimes crystals of lime. Scattered in the sarcode-substance are numerous yellow cells, *c c*, which Professor Hæckel regards as having a liver's function. Besides this there may be a siliceous skeleton embedded in the sarcode, sometimes only a few spicules, at



other times of great beauty and elaboration. Professor Huxley was himself the first to draw the attention of naturalists to the large floating forms which he called Thalassicolla, and which have the same essential structure.

With regard to the Infusoria some new statements were made which are of interest. A distinct cuticle must be admitted to exist in them continuous with their cilia, though in the Amœbæ and Gregarinæ such a structure is not recognizable. The latest researches of Stein (who has published a second great folio) and others, still leave the cause of the rotation of the food in the semi-liquid body-cavity unknown; but it is suggested that a cause similar to that operating in the circulation in plant-cells is at work. A distinct anal aperture has been recognized in many Infusoria; it is visible only when in use. The contractile vesicles have a permanent direct

communication with the surrounding water. The idea that Infusoria are "unicellular" animals must be abandoned, for the researches of Müller, Claparède, and Balbiani, have shown that the so-called nuceus and nucleolus, play respectively the parts of quasi-ovary and testis. Balbiani thought that when two Infusoria became conjoined, the testis or nucleolus of each changed over to the other. Stein, however, denies this; he states that there is no exchange, but merely an apposition which acts as a stimulus to the growth of the ovario-nucleus. This body then splits up into several segments, each of which becomes an embryo Infusor, presenting the larval *Acineta-form.* The *Acineta-form* is characterized by the sucker-like pseudopodia, which are also found in the unciliated adult genus *Acineta.* The connection between *Vorticella, Podophyra, Acineta,* and *Actinophrys,* which Stein at one time maintained, he now abandons. He has, however, made a very interesting observation as to the sexual forms of Vorticella. No one had ever detected a male Vorticella, *i.e.*, a Vorticella with a nucleolus or testis, only the great crescentic nucleus was seen, as shown in *b*. Professor Stein believes that just as the sexual conjugation of *Paramœcium, f,* was at one time mistaken for a process of budding or fission, so here the bodies like *c*, which have been called buds, are really the male Vorticellæ, which swimming freely as at *d*, attach themselves to the stalked females, and are gradually and completely absorbed into her. This conjunction of two individuals originally born separate is of great interest, appearing as the normal condition in Infusoria. Amongst the worms there is a remarkable example, the *Diplozoon,* and also the *Sphærularia,* the latter parasitic in humble-bees, in which something of the same sort occurs.



ON THE NEW THEORIES IN CHEMISTRY.

BY F. S. BARFF, M.A. CANTAB., F.C.S.,

Assistant to Professor Williamson, F.R.S., University College.

No. II.

If the air be exhausted from a vessel capable of containing 11·2 litres (the weight of the vessel being known and balanced by a counterpoise), and if it be filled with hydrogen at the normal temperature and pressure, *i.e.* zero, centigrade, and 760 mm. of mercury pressure, it will be found to weigh one gramme, that is, the weight of the hydrogen which has taken the place of the air will be one gramme. If the hydrogen be withdrawn, and oxygen made to take its place, the oxygen will be found to weigh 16 grammes; and also 11·2 litres of nitrogen weigh 14 grammes; the atomic weights in grammes of those elements which are gases or can be vaporized will, in the gaseous state, occupy a volume of 11·2 litres; but the molecular weight of compounds taken in grammes will occupy 22·4 litres, because their molecules occupy two volumes. It is useful, therefore, to take the atomic volume as 11·2 litres, as it simplifies calculations. For example, if it is desired to know how much chlorate of potash will be required to furnish 50 litres of oxygen, it is only necessary to divide 50 by 11·2, this will give the number of atomic volumes, and that number multiplied by 16 will give the *weight* of oxygen required, and the weight of chlorate necessary to yield this quantity can be found by multiplying the molecular weight of chlorate of potash by the found weight of oxygen, and dividing by the weight of oxygen contained in a molecule of chlorate of potash. The molecular weight of chlorate of potash $KClO_3$ is—

$$K = 39 \quad Cl = 35{\cdot}5 \quad O_3 = 48 \quad 39 + 35{\cdot}5 + 48 = 122{\cdot}5$$

$$\frac{16 + 50}{11{\cdot}2} = 71{\cdot}42 \left\{ \begin{array}{l} \text{grammes of oxygen in 50} \\ \text{litres.} \end{array} \right.$$

$$\frac{71{\cdot}42 + 122{\cdot}5}{48} = 182{\cdot}268 \left\{ \begin{array}{l} \text{required weight of} \\ \text{chlorate of potash.} \end{array} \right.$$

Similar calculations will give the quantities to be taken of any substance or substances for the production of a required volume of any gas; as, how much zinc and sulphuric acid must be used to

make 100 litres of hydrogen. It will not be necessary to work this out, as it would be almost a repetition of the preceding example.

A further confirmation of the correctness of the atomic weights of the elements now in use, has been obtained from their specific heats. It is known that, when equal weights of different substances are heated to the same temperature, they do not cool with equal rapidity; one body has required less heat to raise it to a given temperature than the other, and it therefore takes less time to lose that heat. If a pound of mercury be heated to 100° C., and be then mixed with a pound of water at 0° C., it will only raise the temperature of the water 3°, and the temperature of the mercury will fall 97°; therefore to raise one pound of water from 0° C. to 100° C. will require rather more than thirty-two times as much heat as is required to raise one pound of mercury to that temperature, and, as the times which equal weights of different bodies require for cooling through the same range of temperature are directly as their specific heats, the pound of water will take three times as long to cool as the pound of mercury. Of all known substances, water requires, for equal weights, the greatest amount of heat to raise it to a given temperature; it is therefore taken as the standard. The quantity of heat which any substance requires to raise it one degree centigrade, as compared with the quantity of heat required to raise the same weight of water through the same range of temperature, is called its specific heat; and as water requires for this purpose thirty-two times as much heat as mercury, if the specific heat of water be taken as 1, that of mercury will be as 1 : 32 approximately; the specific heat of mercury, as determined by M. Regnault, is 0·03332. Messrs. Dulong and Petit found that, if instead of equal weights, weights in proportion to the atomic weights of different substances were taken, the same quantity of heat was required to raise them to the same temperature. Thus, 200 parts of mercury and 118 parts of tin will, under the action of the same quantity of heat, be raised to the same temperature, and the specific heat of mercury multiplied by its atomic weight will give nearly the same number, as will the atomic weight of tin multiplied by its specific heat. The atomic weight of mercury is 200, and its specific heat 0·03332—

$$200 \times \cdot 03332 = 6\cdot 664.$$

The atomic weight of tin is 118, and its specific heat 0·05623—

$$118 \times 0\cdot 5623 = 6\cdot 63514.$$

Dulong and Petit therefore deduced the law that, *the specific heat of*

an elementary body is inversely as its atomic weight, so that all atoms have the same specific heat. In determining specific heats, the sources of error are so numerous that it is difficult, if not impossible, to attain to perfect accuracy, and therefore the products obtained by multiplying the atomic weights of elements by their specific heats do not always give exactly the same results; still they are sufficiently near to determine between two supposed atomic weights of any element, as, for example, it is clear, judging from this point of view, that the atomic weight of mercury cannot be 100, as was formerly asserted, or that that of phosphorus is not 62, as its vapour density seems to require, although the product of its atomic weight multiplied by its specific heat, does not give the exact constant 6·666; but comes somewhat below it—

$$31 \times \cdot 18949 = 5\cdot 87419;$$

it is, however, much nearer than if 62 were adopted as the atomic weight of phosphorus. Under the old system of atomic weights, some elements had only half the atomic specific heat of others (the atomic specific heat being the product of the multiplication of the specific heat by the atomic weight). Thus, bromine and iodine, in the solid state, gave respectively 6·744 and 6·8732 as their atomic specific heats, whereas, iron and zinc gave 3·1861 and 3·1054. Two examples only from each class are given here, as sufficient for illustration; a reference to the tables of the different atomic weights in any treatise on chemistry will show all the cases in which the difference occurs. The atomic specific heat of iron, as above quoted, is obtained by multiplying its specific heat by 28, thus:—

$$\cdot 11379 \times 28 = 3\cdot 1861.$$

28 was the old atomic weight of iron, whereas that now used is 56, and it, multiplied by the specific heat of iron, gives a near approximation to the constant 6·666—

$$56 \times \cdot 11379 = 6\cdot 3722.$$

And a similar result is obtained in the case of zinc; its specific heat multiplied by its old atomic weight gives an atomic specific heat of 3·1054—

$$32\cdot 5 \times \cdot 0955 = 3\cdot 1054$$
$$\text{and } 65 \times \cdot 0955 = 6\cdot 2108.$$

65 therefore is adopted as the present atomic weight of zinc. The evidence thus obtained, added to what is afforded from other sources of a nature similar to that alluded to in the early part of the first

article, shows clearly the necessity there was for doubling the atomic weights of certain elements, such as oxygen, sulphur, tin, and others whose compounds could not be accounted for rationally on the old system, and which were exceptions to what seemed so universal a law as that which we have just been considering. There are, however, some exceptions to it in the case of carbon, silicon, and boron. The specific heat of diamond is 0·1468; of graphite, another form of carbon, 0·2018; and of wood charcoal, 0·2415: these multiplied by 12, the atomic weight of carbon, give different atomic specific heats. Sir B. Brodie made experiments which lead him to form the conclusion that graphite acts the part of a separate element, forming a series of compounds in which it had an atomic weight 33. This multiplied into the specific heat of graphite, 0·2018, would give the constant 6·666 nearly—

$$\cdot 2018 \times 33 = 6\cdot 6594.$$

However this may be, all these three elements exist in different states, which are termed allotropic modifications, and in each the specific heats of the several modifications are different; nor is it difficult to understand why this should be so, since the aggregation of the particles in each case is so different, and the bodies themselves show such different properties, that it seems natural to conclude that Sir B. Brodie's view with respect to graphite may, at some future time, be found to hold good with respect to the other elements, boron and silicon, in their modified states, and that in each they will be found to play the part of separate elements. Compounds obey the same law as elements as regards their specific heat. M. Wœstyn found that the molecular weight of a substance, multiplied into its specific heat, will give some multiple of the constant 6·666, and the number of times which it is contained in the product will represent the number of atoms contained in the molecule. This last fact enables us to determine the atomic weights of gases. Suppose it is desired to find the atomic weight of chlorine: if tin be dissolved in hydrochloric acid, a salt will crystallize out, the specific heat and molecular weight of which can be determined by experiment; its specific heat will be found to be 0·0939, and this multiplied by 189, its molecular weight, will give the product 17·7471; dividing this by the constant 6·666, the quotient will be 2·662; and as a fraction of an atom can take no part in a compound, the number of atoms being more than two must be three. As the atomic weight of tin is known to be 118, the difference between it and 189, the molecular weight of the chloride, will be 71; and

as in the compound there is but one atom of tin—for if there were more its molecular weight would be higher than it was found to be—there must be two atoms of chlorine; and therefore the atomic weight of chlorine will be $\frac{71}{2}$, that is, 35·5, and the formula of the chloride of tin will be $Sn\ Cl_2$.

It has been seen that hydrogen unites with oxygen in the proportion of two to one, and that the property which oxygen has of uniting with two atoms of hydrogen, or any other similar monovalent element, is called its "valency;" but sixteen parts by weight of oxygen unite with two parts by weight of hydrogen. Therefore eight parts of oxygen are *equivalent* to one part of hydrogen, and therefore the *equivalent* of oxygen is said to be eight; that is to say, in a re-action eight parts of oxygen can be supposed to replace one of hydrogen. The atomic weight of nitrogen is fourteen, and we have the compound NH_3, ammonia, here; three parts of hydrogen unite with fourteen of nitrogen, and therefore the equivalent of nitrogen is $\frac{14}{3} = 4{\cdot}6$; but nitrogen also combines with five monovalent atoms in $NH_4\ Cl$, chloride of ammonium. It here has another equivalency. In ammonia 4·6 parts of nitrogen are equivalent to one of hydrogen, and in chloride of ammonium it has the equivalent value $\frac{14}{5} = 2{\cdot}8$. This has been regarded as a difficulty, as being at variance with the new theory of atomic weights, and different explanations of it have been proposed. There does not, however, seem any reason why an element should not have two, or even more, combining proportions with the same atomic weight; what is maintained is, not that varying numbers of a monovalent element may combine with one of higher valency, but that no less a weight of that element than its atomic weight can enter into combination with one or more atoms of any other element. Less than sixteen parts of oxygen cannot combine with one or two of hydrogen; less than fourteen of nitrogen cannot combine with three or five of hydrogen, or of any element like hydrogen. If NH_4 be regarded as a metal or basic radical, it must be monovalent, for reasons which will be given hereafter, and it unites with one atom of chlorine in chloride of ammonia; but however the constitution of this salt may be regarded, the fact remains that nitrogen is in it pentavalent. The term combining weight is not, therefore, the same as atomic weight, nor should it be used instead of it. Still less correct is the use of the term equivalent in the sense in which it was formerly used, namely, as synonymous with atomic weight. Dr. Williamson says, in his "Chemistry for Students," "the term 'equivalent' is really synonymous with 'capable of replacing.' It is not intended to

convey the idea of any equality of properties," and this seems to express clearly the meaning and full force of the word. The equivalent of an element can always be ascertained by dividing its atomic weight by the number of atoms of hydrogen, or any other monovalent element with which it can combine.

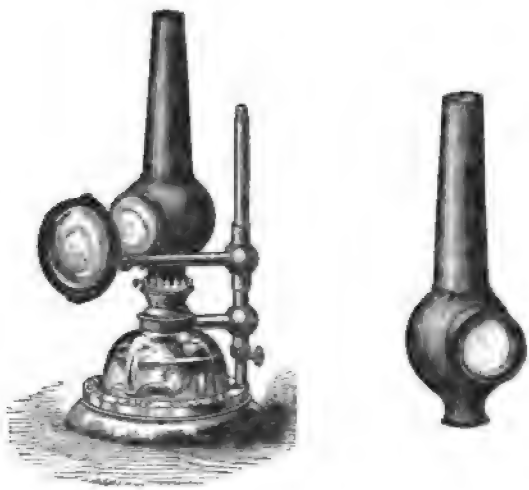
The new atomic weights and the grounds upon which their adoption rests, the constitution of molecules and the laws relating to combination by volume, have been treated somewhat at length, because on the correctness of the principles on which they are based depends the truth of the theories to which they give rise; and without a clear knowledge and thorough appreciation of their merits, it will be impossible to realize the beautiful order and consistency which they have been the means of introducing into the classification of compounds, and into the interpretation of the laws which govern chemical combination and decomposition; not but that there are anomalies which wait for their explanation as research advances, and which, on their being thoroughly understood, may considerably modify theories which at present seem unassailable. But whatever changes may take place, we, at least, know that the endeavours of our most philosophical chemists have been given to render rational what was formerly but empirical; and if the grounds of their reasonings be, in some points, proved defective, still they will have the satisfaction of knowing that they were the originators of that method of thinking and reasoning, which has led to a more rational and correct knowledge of natural phenomena, and has raised their science to a place amongst those which engage the highest powers of the human intellect.

(*To be continued.*)

NEW CHIMNEY FOR MICROSCOPE LAMPS.

Mr. Collins has given us an opportunity of trying a new chimney for microscope lamps, with which we are much pleased, though more prolonged experience is necessary to enable us to speak positively on some points. He calls it "Fiddian's Metallic Shade Chimney," the special method of constructing having been devised by Mr. Fiddian, of Birmingham. It can be fitted to any of the paraffin or photogen lamps ordinarily in use. It consists of a stout tube of copper, formed by the electrotype process in one piece without joints, and has, as the drawing shows, a bulge at the part where

the lamp flame comes. In this bulbous portion a cap fits carrying a flat piece of glass, through which the light passes, no light being



FIDDIAN'S METALLIC LAMP, CHIMNEY, AND SHADE.

emitted in other directions. The inside of the tube is coated with plaster of Paris, which improves the quality of the light, and renders it very intense. It is very pleasant, when using the microscope with this lamp, to have all extraneous light so neatly and completely excluded, without the aid of any cumbersome screen.

This chimney seems to improve the combustion of the paraffin, by burning it at a somewhat higher temperature than when a glass chimney is employed; and hence, as we are informed by Mr. Collins, and as appeared from several hours' trial, there is much less tendency to smoke. Even tilting the chimney considerably on one side did not provoke smoking. As this chimney is quite new, we are not able to say how many months it might be used without requiring a fresh coat of plaster of Paris, but when necessary it is very easy to give it. A little plaster of Paris made into a cream with water is poured in, and allowed to run round by inclining the tube, and the thing is finished.

LITERARY NOTICES.

Faraday as a Discoverer. By John Tyndall. (Longmans.)—Professor Tyndall's lecture on the life and discoveries of Faraday make an octavo volume of 171 pages, filled with interesting matter, and adorned by two excellent portraits, taken at different periods in the life of the great philosopher. As a brief but excellent summary of the remarkable services which Faraday rendered to science, the present work will be heartily welcomed, and it will be still more esteemed as an eloquent and touching memorial, erected by friendship in honour of one of the most single-hearted and noblest of men. Faraday won for himself the highest rank as an experimental discoverer, and with rare devotion refused opportunities of making a large fortune, and laboured for a mere pittance as an interpreter of nature to his fellow-men. Faraday was a self-made man. At thirteen he was apprenticed to a bookbinder in Blandford Street, Manchester Square, with whom he worked for eight years, and then served as a journeyman. Gaining access to a course of Davy's lectures at the Royal Institution, he took notes of them, and applied to him for employment, and became his assistant at weekly wages, thus humbly entering upon a scientific career. Biographical notices of Faraday have so recently appeared in all the newspapers, that it is not necessary for us to recapitulate the events of his quiet life. In his wonderful course of discovery in chemistry, electricity, magnetism, and many other subjects, and in the warm affections of his domestic hours, he is beautifully sketched by his friend and successor. Such a memoir is worth a host of long-winded biographies, and England, justly proud of the fame of Faraday, may rejoice that she has a Tyndall to render the homage of enlightened admiration, and in some directions at least to continue his profound research.

British Social Wasps. An Introduction to their Anatomy and Physiology, Architecture, and General Natural History. With Illustrations of the different species of their Nests. By Edward Latham Ormerod, M.D., Caius College, Cambridge, Fellow of the Royal College of Physicians, Physician to the Sussex County Hospital. (Longmans.)—Dr. Ormerod's book is sure to prove a popular one, as students and observers of matters pertaining to natural history are now scattered all over the country. Much of his work is avowedly compiled from accredited sources, but it contains a considerable body of original observations, and is illustrated by a beautiful series of drawings of wasps' nests made by Mrs. Ormerod, and fully justifying her husband's statement that there can be but one opinion about them in accordance with his own. There are also coloured figures of English wasps. Dr. Ormerod's affection for wasps leads him to declare that wasp-keeping is as profitable as bee-keeping, to which we apprehend bee-keepers will demur; but his book will induce many to forego their dislike to an insect not

overburdened with public favour, and to watch its highly curious habits and proceedings. It will appear that, during the busy and most interesting portion of a wasp's life, the creature is inoffensive unless assailed. It is when the work is done and the society broken up, that wasps become a nuisance, like other idle folks. We could have wished Dr. Ormerod had drawn more largely upon notes of his own observations, as he must have met with many important illustrations of what it is the fashion to call the instinct of these creatures, though much of it is indistinguishable from the reason of higher animals, except in degree. He tells us that if a wasp's nest is destroyed early in the season, the insects make a new one, and will do so several times in succession. "Each of these successive nests bears more than a mere generic resemblance to the original structure, the peculiarities of the preceding nest being in some sort reproduced. They do not, however, pass through all the same stages as the original fabric in their development, for they are built up at once, on the scale and outside plan of that which has been removed. And this fact necessarily involves some important differences in the details of their construction; for instance, the upper part or crown of the nest is not made of the remains of older structures worked into each other, but of distinct sheets of paper closely applied one over the other.... Again, the new camp differs from the original structure, the formation of the cells is less regular, and the stages are arranged differently.... Each time that the nest is replaced it differs more and more from the original type," and after it has been destroyed three or four times, the survivors make no attempt to replace it. Dr. Ormerod should publish further matter of this sort, with some more of his wife's excellent drawings to illustrate the successive changes the wasps make.

JERROLD, TENNYSON, AND MACAULAY, with other Critical Essays. By James Hutcheson Stirling, LL.D., author of the "Secret of Hegel," etc. (Edmonstone and Douglas.)—Essays upon well-known living characters and their writings, or upon authors recently departed and whose works are in frequent circulation, are very ticklish things. It is supposed by the credulous that ponderous magazine essays of this kind actually find readers. Dr. Stirling's essays have much more than average merit, and though we differ from him on some points, we find much to agree with. The most interesting of his papers refers to Ebenezer Elliott, and for this we heartily recommend his volume to our readers. Elliott was a noble spirit, and though thoroughly appreciated in some circles, was not known too widely to take the edge off the interest of such a notice as Dr. Stirling has given him.

GROOMBRIDGE'S ANNUAL READER, and Repertory of the Principal Events of the year, from October, 1866, to October, 1867, for the use of Schools. By Mark Antony Lower, M.A., F.S.A., Member of the Academy of Sciences of Caen, etc. (Groombridge and Sons.)—The idea of this book is exceedingly good, and the execution such as to give it a firm hold on

the class for whom it is intended. It is, however, not exactly "a repertory of the principal events of the year," nor do we think such an encyclopedic character would be advisable for the purpose in view. It is a well-made selection from the events of the year, recorded and commented upon in a style that will win the attention of pupils in the better sort of schools, and supply them with a large amount of useful information. There has been a great want of books adapted to reading aloud, and possessing the sort of qualities which we are glad to recognize and welcome in "Groombridge's Annual Reader." It is frequently not advisable to select for class reading portions of large works. If the work is a good one, taking it piecemeal may spoil a boy's interest in it for life. Judicious selections, fitting particular times and circumstances, a teacher fit for his vocation, and in possession of a good library, can easily make; but things actually going on, history just fresh from making, has a great and invaluable charm. The first volume of "Groombridge's Annual Reader" contains more than seventy articles on a great variety of topics belonging to the year. Some notice of the Atlantic Telegraph, under the title "Those whom the Queen Delighteth to Honour," is followed by the "Meteoric Shower," "Attempt to Assassinate the Emperor of Austria," "Dreadful Fire at Quebec," "Visit of the Prince of Wales to Russia," "Great Frauds in the North of England," etc., etc. Science, politics, wonderful incidents, social events, and archæological discovery, all make their appearance in Mr. Lower's pages, and the volume, handsomely printed, has been judiciously limited to about 400 pages, so that it can be sold at a very moderate price. Though avowedly intended for schools, its circulation ought not to be limited to such establishments. It is a good popular work, and might be widely circulated with advantage.

A SHORTHAND DICTIONARY; comprising a complete alphabetical arrangement of all English Words, written without Vowels, adapted to all systems of Shorthand Writing, and designed for the use of gentlemen connected with the Press, the Bar, the Pulpit, and other professions. By J. B. Dimbleby. (Groombridge and Sons.)—Those who wish to learn shorthand, and those who have learnt a little of its use, should have this book, as it will save them a world of trouble and vexation. The practice of writing shorthand would increase much quicker if the task of reading it when written presented fewer difficulties, and Mr. Dimbleby has produced exactly the right sort of work for this purpose. Many words reduced to the shorthand standard by the omission of vowels are easy enough to understand, but dreadful puzzles continually arise in the way of all but well-practised stenographers. This compact, portable dictionary will afford welcome and inestimable aid. Suppose, for example, the letters bnls are encountered, and that memory has lost the clue to their interpretation, and that the context does not force it into notice, what a comfort to have a book to refer to which at once gives a

choice between biennials, boneless, baneless, and boonless; or take gs, which may stenographically indicate gas, gauze, gaze, geese, goose, guess, guise, Jesus, joyous, juice, ages, eggs, goes, gags, gaseous, joys, and gigs, and it will be at once seen how much such help is needed as Mr. Dimbleby affords. Shorthand students can appreciate the difficulties of translators of Hebrew written without points, and thus to some extent resembling their own mode of writing, and supplying analogous puzzles to commentators.

An Elementary Treatise on Conic Sections and Algebraical Geometry, with numerous Examples and Hints for their Solution, especially designed for the use of Beginners. By G. Hale Puckle, M.A., St. John's College, Cambridge, Head Master of Windermere College. Third edition, revised and enlarged. (Macmillan and Co.)—It is only necessary, on the appearance of a new edition of an established work, to notify the fact of its issue, and to mention any important changes. Mr. Puckle says, in reference to this third edition of his book, that he has re-written and re-arranged a large portion of it, and thoroughly revised the examples. A mathematical work never comes to a third edition without possessing considerable merit, and that of Mr. Puckle is well known.

The Life of Sir John Richardson. By the Rev. John McIlraith, Minister of the English Reformed Church, Amsterdam. (Longmans.)—The famous Arctic explorer whose biography is now presented to the public well deserved a popular record of his services, and of his fine-hearted character. His career was a very honourable one, and he won his way upwards by qualities eminently deserving of respect. This life of him, without reaching any high degree of merit, is fairly and interestingly done.

The Mineralogist's Directory; or, A Guide to the Principal Mineral Localities in the United Kingdom of Great Britain and Ireland. By Townshend M. Hall, F.G.S. (Stanford.)—This is a very handy book for mineralogists and geologists, with which Mr. Hall has evidently taken great pains. The various counties in Great Britain and Ireland are arranged alphabetically as chapter-headings; under each an alphabetical list is given of the places at or near which characteristic minerals are to be found. Preceding this main portion of the work is a list of 246 British minerals, with their chemical composition. At the end of the volume the localities of pseudomorphic minerals are separately given, followed by an appendix, containing useful chemical and geological notes.

Mr. Hall puts forth this convenient little volume in a very unpretending spirit. It represents a large amount of labour, and cannot fail to be valued by tourists interested in the objects to which it refers. We hope he will receive sufficient encouragement to bring out a second edition, with such additional information as may be communicated to him, and in that case we would suggest a few more hints as to the precise locality of some of the rarer minerals.

ARCHÆOLOGIA.

At a recent meeting of the British Archæological Association, Mr. Syer Cuming, one of its vice-presidents, made an interesting communication on the remains of large Roman bronze statues which have been at different times found in London. The Roman bronzes found in Britain, though often of very good workmanship, are generally of small dimensions, and fragments of statues of bronze of any magnitude, for it is only fragments we find, are extremely rare. In fact, only four such fragments are at present known to have been found in London. The most remarkable of these is a fine colossal head of the Emperor Hadrian, dredged up from the bed of the river Thames a little below old London bridge in 1832, and now deposited among the treasures of the British Museum. A good engraving of it was given with the first volume of the Transactions of the British Archæological Association. Mr. Cuming pointed out, as a singular circumstance, the fact that all the other evidence we possess of the existence in Roman London of large bronze statues has come to us in the remains of hands, and that they have all been found within a very limited space, and on the eastern side of Roman London. In 1855 was found, towards the Tower Hill end of Lower Thames Street, a right hand of bronze, with the first joint of the thumb broken off, the index extended, and the three other fingers folded on the palm. The wrist was eleven inches in circumference, and the whole length thirteen inches. It was formerly in the collection of Mr. Roach Smith, but is now in the British Museum. In 1833, in the course of excavations in Fenchurch Street, among a considerable number of relics of the Roman period, there were found two bronze fingers, which Mr. Cuming exhibited in illustration of his paper. They had evidently been broken from a very large muscular hand. They were severally five and four-and-a-quarter inches long. As, close to these antiquities, were found very handsome tessellated pavements and the bases of walls, Mr. Cuming thinks that the statue to which these digits belonged may have stood in the *atrium* of some mansion of importance. The last discovery of this kind occurred in the middle of the month of October, 1867; it consisted of a well-proportioned left hand, which was found on the site of the old inn, the *Spread Eagle*, in Gracechurch Street. It also was exhibited at the meeting to illustrate Mr. Cuming's paper. Its dimensions are: Length from the tip of the finger to the fractured edge of the wrist,

nine inches and three-quarters; breadth across the knuckles, four inches and a-half; circumference of the wrist next the hand, seven inches and five-eighths; circumference at the fractured end, eight inches and a little more than five-eighths. The thumb and the first and second fingers are nearly extended, but the two other fingers are folded towards the palm, the little finger having sustained a blow, which gives it rather a hooked form, and has produced rather a slight fissure on the back of the hand. Traces of gilding were perceptible on some parts of the surface. This hand also was found near a handsome tessellated pavement.

These are all the traces of bronze statues hitherto known to have been found in London. Mr. Cuming enumerated as the sum total all the remains of objects in this metal of any considerable size found in the whole of Britain, out of London, the superb helmet, with its persona, found at Ribchester, in Lancashire; and the statuette of the loricated soldier found near Barking Hall, in Suffolk, in 1799 (both now in the British Museum); the leg and hoof of a horse, found at Lincoln (now in the Museum of the Society of Antiquaries of London), and the head of Apollo, exhumed at Bath.

Perhaps we may be able to throw some light on the cause of the hands or fingers only of so many of these statues being preserved. The people of the middle ages, those who came here after the Romans, were ignorant and superstitious, and they believed that the works of Roman art which remained were filled with enchantment and magic. A Roman inscription was, to them, a dangerous charm, the more so as they could not read the letters, and they believed that the force of the charm could only be destroyed by mutilation. In very recent times, the peasantry of Northumberland along the line of the wall of Hadrian were accustomed, when they turned up an inscribed Roman stone, to erase some of the letters with a pick or axe, before they would venture to use it for building purposes. All bronze figures of human beings were supposed similarly to contain a dangerous spell, which could only be broken by mutilation of the figure; and this is the cause of our finding so many mutilated small bronzes. When people found a bronze statuette, their first impulse was to destroy the spell it might contain by mutilating it with an axe, or any other implement at hand, and they then threw it away—the Londoners often into the Thames, and hence so many mutilated bronzes have from time to time been dragged from the mud of the river. But these same people were quite alive to the value of bronze as a metal, and they

were not inclined to lose so much of it as was contained in a colossal statue, though they still had the same fear of the charm, and sought to get rid of it by the same process of mutilation the moment they found it. It is evident that the part of a large statue easiest to hew or cut off was the hand, and there can be little doubt that for this reason they struck off the hand of the statue and threw it away, and then proceeded to appropriate the metal of the body for other purposes.

We are able to add some particulars to the account of the Excavations in Bath, described in our last. The ancient remains brought to light belong to two periods, Roman and mediæval, the latter chiefly ecclesiastical, for the site of the ancient temple had, as was not unfrequently the case, been seized upon partly for the foundation of an abbey, and here stood the church of St. Mary le Stall, built in early Norman times, which gave to the present thoroughfare the name of Stall Street. The excavations were commenced in September of last year, for laying the foundations of the front wall of the wing of the hotel adjoining Westgate Street, and among the first discoveries was that of a quantity of mediæval pottery, among which were some fragments of a very fine example of the curious glazed earthenware figures, generally of a knight on horseback, of which several examples are now known, and they are mostly of a rather early date. This example appeared to be not later at least than the time of Edward I. Remains of the old ecclesiastical buildings, etc., were found, with some early sepulchral monuments. A strong wall of the Roman period was also met with; it was two feet three inches thick, and its lower part was built with herring-bone work, and went down into the unmoved blue clay. During the following month, many remains of the old ecclesiastical buildings were brought to light, and towards the end of the month the workmen came upon a rough Roman pavement, formed of concrete, covered with thin slabs of pennant stone, which was found to be close to the Roman temple. The month of November was rich in discoveries, chiefly of remains of the Roman period. These consisted for the most part of walls running in different directions, and it was eventually found that the excavators had got into the open court of a Roman building, with low lean-to buildings round the exterior walls, and that the buildings of the new hotel covered the greater part of this open court. On the 20th of November, under the foundation of the north-west partition of the central portion of the hotel, a fragment of a fine churchyard cross of rich Norman work was found. It was the lower arm, and bore

part of the eagle, the emblem of St. John, and the circle which had united the arms. Other remains of mediæval sculpture and architecture were found, which Mr. J. T. Irvine, well known as a careful investigator and observer, thinks may be Anglo-Saxon. Towards the end of November, the excavators came upon the raised platform of the Roman temple, which was formed of solid masonry, and several portions of it appear to have had forced holes sunk in them, to form cess-pools. Early in December, a circular well was discovered, close to the exterior of the south wall of the stairs to the new hotel. It was about fifteen feet deep, and was roughly paved at the bottom, the walling being entirely composed of fragments from the abbey buildings, mostly of Norman and early English date. In clearing it out, were found the lower portion of a fine column of the perpendicular style, supposed by Mr. Irvine to have formed part of the rood-screen of the abbey church, an old bucket, and many fragments of pottery, all of a date subsequent to the year 1500. On the 6th of January, the foundation of the south wall of the temple was discovered, but one course only of the immense stones which formed it remained. One stone was more than five feet long, and had a sawn face, proving that the stone saws used by the Roman masons could not have been less in length than those used at the present day. Close to the wall, a beautiful glass mask was found, which had been originally attached to a vessel of thin glass. A Roman wall has been since found, parallel to the south wall of the temple. The excavations are discontinued for the present, but it is intended to resume them on a future occasion, and then we understand they are to be carried on not far from the Cross Bath, and we may hope for antiquarian discoveries of very considerable importance.

At a recent meeting of the Archæological Institute (Feb. 7), Mr. Edward Tindall of Bridlington, in Yorkshire, exhibited a very large collection of FLINT IMPLEMENTS, gathered by himself on the wolds and plains of that part of the EAST RIDING in which Bridlington is situated. Mr. Tindall has been known for many years as an active and zealous collector of these objects, and these are especially important—from the circumstance that we know them to have been found by himself personally, on the surface, or not very far below the surface of the ground, and in some cases on the sea-shore. This district was during the Roman period, and long after the Roman period, an extremely retired and wild part of the country, and had no doubt little communication with the more cultivated parts of Britain. We need no stronger proof of this than the fact

that, even in Anglo-Saxon times, its streams were frequented by beavers, from which circumstance one of its earliest religious foundations took the name of Beverley, the field of beavers. The inhabitants of this district seem to have lived chiefly by the chase, and a large majority of these flint implements were weapons which were used for killing quadrupeds, birds, or fishes, consisting of such articles as sling-stones, arrow-heads, and fish-hooks. The barbed arrow-heads and barbed fish-hooks were evidently made by men who were well acquainted with similar objects made of metal, of which they are imitations, and there is no reason whatever to suppose that these flint implements generally belong to an older period than that of the Romans. In a retired district like this, when intercommunication with the rest of the world was slow and uncertain, metal would not be always available, and would no doubt be dear. Mr. Tindall's collection is of so much interest in connection with Yorkshire, that we cannot but hope that it will eventually be secured for one of the great local museums, at York or Leeds.

A few weeks ago, at a former meeting of the Archæological Association, Mr. George R. Wright, the Secretary of the Junior Athenæum Club, and one of the officers of the Association, exhibited a finely-sculptured head, in marble, which he had received from Alexandria, where it was dug up in a garden. It was ascertained that the body of the statue also lay buried in the same spot, but it had been left undisturbed. It was the general opinion that the head belonged to a statue of the Roman emperor Marcus Aurelius Antoninus, who reigned from A.D. 161 to 180.

T. W.

PROGRESS OF INVENTION.

Manufacture of Charcoal, by C. Dromart.—On account of the value of wood, an economical method of converting it into charcoal is very desirable. The advantage of M. Dromart's method over the old system of burning in heaps is very great, he effects a saving of at least 30 per cent. of wood at a comparatively less cost. The apparatus he employs is of a dome-shape, the diameter of its base being 5·25 metres, and its height 4·50 metres. At the top it has a chimney a metre high, and 0·7 metre diameter; this chimney is tubulated, so that a fire can be lighted in it to cause a draught. The framework of the dome is formed of an iron ring, with curved ribs of iron attached to it, and which give the top its dome-like shape; they are connected above by an iron ring,

to which the chimney is fixed; the intervals between the ribs are closed hermetically by thin iron plates. The whole iron should not weigh more than two hundred kilogrammes, so that it can be moved about easily. A second iron covering serves as a protection against rain; and to prevent the escape of heat, the apparatus is covered with earth to the thickness of two metres. The holes for the draught and two doors are made of wood curved to the form of the iron-work. For heating the chamber, an apparatus is made of cast-iron and Stourbridge clay, and is placed beneath it; to this are connected ten tubes, arranged in the form of a fan, so that the heat may be equally distributed to the whole; by opening and closing these tubes the heat is regulated. The wood is then carefully packed within the chamber in the usual manner, a strong fire is made on the hearth, which is kept burning during the operation, that in the chimney being only used for a short time to create a draught. In ten hours the temperature of the stove is 100° C.; the water then goes off; at 150° C., dark fumes pass out; these are caused by volatilization of the tar; at 330° C., no smoke is seen, and then the process is completed. To obtain a stronger charcoal from denser wood, the temperature should reach 420° C., and should be continued for an hour and a half. The temperature is determined by melting metals. The advantages of this method, beyond the greater yield obtained by it, are, that there is no fear of loss from explosions, men easily learn to work it, and the time occupied in making the charcoal is much less than that required by the common process.

An improved Sink Trap.—As it is very desirable to prevent the rising of impure and deleterious gases from sinks, etc., any simple and effective method of doing so will be very acceptable. The present invention is one which requires no springs, or complicated apparatus liable to get out of order; it consists of a ring with a broad projecting flange, which rests on the bottom of the sink immediately over the pipe, and can be secured in the usual manner; to the barrel of this ferrule are pivoted two half funnels, which together form a hollow cone. These project downwards into the pipe, and when empty, that is, when nothing is passing through them, close by their own weight, but when liquids are passing through from above they are forced open. When closed, the longitudinal joint between the two halves of the cones, is air and water-tight, and wholly prevents the escape of unpleasant and noxious effluvia. The flange may be constructed to stand at an angle with its barrel without destroying the action of the two half funnels. These may be made in three parts, if desired; the only objection being the formation of another air-tight joint. It may also be used to admit volatile liquids to a vessel, but prevent their escape by evaporation.

Aluminium Glass has been made by melting respectively 40, 50, 60, and 80 parts of alumina with a mixture of 250 parts of pure sand, 100 parts of carbonate of soda, and 50 parts of carbonate of lime. These

glasses, produced by M. C. Pelouze, have been specially examined by M. Baille; he found their indices of refraction to be as follows:—

	40	50	60	80
For line C ...	1·5115	1·5120	1·5143	1·5153
„ D ...	1·5133	1·5137	1·5159	1·5167
„ F ...	1·5210	1·5211	1·5224	1·5232
Middle index...	1·5172	1·5174	1·5192	1·5200

Therefore the index of refraction increases with the alumina, but dispersion decreases; its co-efficient being in the several cases—

0·00185, 0·00177, 0·00154, 0·00153.

Whereas, in crystal glass the power of refraction and dispersion increase with the per centage of lead employed.

RESULTS OF EXPERIMENTS ON AIR IN ROOMS LIGHTED BY ARTIFICAL LIGHT, BY DR. BRANISLAW ZOCH.—These experiments were made with gas, petroleum, and oil, and the quantity of carbonic acid formed in a given time was measured. They were made in a space of 100 cc., lighted by a light equal to ten normal flames, and the following results were obtained:—

Time.	Petroleum.	Gas.	Oil.
1 hour	0·0929	0·0708	0·0537
2 hours	0·1456	0·1342	0·1038
3 hours	0·1779	0·1513	0·1190
4 hours	0·1811	0·1562	0·1229

Hence petroleum for equal light gives more carbonic acid than gas, and gas more than oil. With petroleum the air became lighter and very disagreeable, not only on account of the carbonic acid formed, but from the volatile products of distillation. These researches show also that in three hours we obtain the maximum of carbonic acid.

A NEW METHOD OF APPLYING COLD IN DISEASES OF THE HUMAN BODY.—Rags dipped in water—in fact, every method of applying water-dressings—is open to the objection that, from the instant of application the temperature of the dressing begins to rise; where *steady* cold is required at a temperature above melting ice, the invention of Dr. Prentiss, of Kansas, U.S., will be found thoroughly efficient. A thin India-rubber tube, seven or eight feet long (longer, if required), is coiled in the form of a lamp-mat, to the desired dimensions, and kept in form by means of bands extending from the centre to the circumference; one end of the tube being left sufficiently long to dip into a pail of water of the required temperature, the other end leading into another pail, placed to receive the water after its passage through the coil. This end should be provided with a stop-cock, or be compressed by a clip, so as to regulate the rate of the current. In this manner a constant flow of water, at any temperature, may be maintained. The smaller-sized tubing answers best.

NOTES AND MEMORANDA.

ASTRONOMICAL ITEMS. — At the Astronomical Society, March 13, Mr. Simms exhibited and described a new instrument for determining latitudes by a method called "American." It consisted in observing the zenith distance of two stars, differing nearly 12 hours in R.A., on each side of the zenith, at no great distance from it, turning the instrument through 180° of azimuth between the two observations. Some observations of small planets (including the last-discovered No. 97), by Dr. Luther, were communicated. The Rev. H. Cooper Key sent some very interesting observations of the planetary nebula 45 Ḥ IV. Geminorum, by which it would appear that it has undergone some remarkable changes since it was observed by the Herschels. Mr. Marth communicated (through Mr. Lassell) a note on the occultation of Aldebaran, which will occur on the 22nd of May next, which will be interesting from occurring within twelve hours of the Moon's conjunction. The disappearance and reappearance will take place respectively at 6h. 26m. and 7h. 12m. in the evening. Professor Hoek, of Utrecht, sent two papers, one on the appearance which would be presented by a swarm of meteors approaching the earth; the other on cometary systems. The Rev. T. W. Webb sent some further observations of the crater Linné. In the "Astron. Nachrn." (1683) is an elaborate paper on the proper motion of 70 p Ophiuchi, by Mr. W. Schur. He makes its distance from the solar system 1,273,000 times the earth's diameter from the sun, and its distance measured in "light years" (as the Germans call the space traversed by light in a year) as 20·1.

THE ACTIVE PORTION OF VACCINE MATTER.—M. Chauveau details to the French Academy the results of experiments, which seem to show that the serum of vaccine matter or of glanders does not communicate the disease by inoculation, but that the virus is contained in the corpuscles or cells.

MICRO-FERMENTS IN CARBONATE OF SODA. — M. Le Rique de Monchy states ("Comptes Rendus"), that if commercial bicarbonate of soda is dissolved in distilled water and filtered, numerous minute moving bodies may be found amongst the residue left in the filter, and that they are able to induce the fermentation of a saccharine solution.

ANTISEPTIC PROPERTIES OF ETHER.—M. Martin states ("Comptes Rendus") that ergot of rye, cantharides, portions of meat, and various other substances liable to attack from worms, insects, or putrefaction, may be preserved by being moistened with sulphuric ether, and kept in hermetically-stopped bottles.

HUXLEY ON THE ARCHÆOPTERYX.—On Jan. 7, Prof. Huxley read a paper before the Royal Society on the Archæopteryx. He considers that Prof. Owen took the right leg for the left, and made similar mistakes with other bones. He considers the bone supposed to be the "furculum" to present the greatest osteological difficulties, and waits for further specimens to elucidate them. He says that he is not aware of any law of correlation which would enable us to infer that the mouth of this animal was a toothless beak. "If," he says, "when the head of Archæopteryx is discovered, its jaws contain teeth, it will not the more, to my mind, cease to be a bird, than turtles cease to be reptiles because they have beaks. All birds have a tarso-metatarsus, a pelvis, and feathers, such in principle as those possessed by Archæopteryx. No known reptile combines these three characters, or presents feathers, or possesses a completely ornithic tarso-metatarsus or pelvis." In many respects he thinks Archæopteryx more remote from the boundary line between birds and reptiles than some living *Ratitæ*.

FRANKISH LADIES OF THE NINTH CENTURY.
(St. Jerome reading to Eustochia and Paula.)

THE STUDENT,

AND

INTELLECTUAL OBSERVER.

MAY, 1868.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

(*With a Coloured Plate.*)

CHAPTER III.

THE FRANKS IN GAUL.

It was the beginning of the fifth century of our era, when the different branches of the great Teutonic race were making their grand and final movement upon the Western Empire. The name of Germans was known to the Romans at a rather early period, as embracing the numerous cognate tribes who occupied the centre of Europe, and who, no doubt pressed forward by the movements of other peoples from behind, were continually seeking to advance towards the west. Cæsar, when he entered upon the conquest of Gaul, encountered the Germans on the borders of that country, and drove them back. It continued to be the policy of the Romans to repress and conquer these peoples through the whole period of their supremacy in the west. Tacitus, before the close of the first century after Christ, describes their manners and condition, which appear to have borne a sufficiently close resemblance to those of the Gauls before they were Romanised. As with the ancient Gauls, the Germans were accompanied in war by their wives and families—it was, in fact, a necessary consequence of the migratory state in which

they lived—and their women cheered and encouraged them in battle, and attended to the wounded. Like the Gauls, in regard to their Druidesses, the Germans looked upon Womankind as possessing something divine in its character, and as communicating with the gods more easily than men; and Tacitus mentions as instances of the veneration thus paid to the sex, the examples of Velleda, and Aurinia, "and many others" (*et complureis alias*). Like the Gauls, as I have said on a former occasion, the men wore the *braccæ*, or breeches. They wore also a dress which fitted close to the body, and over it a *sagum*, or mantle. Tacitus tells us that the women adopted much the same clothing as the men, except that they were more usually clad in linen garments dyed purple, and that they did not extend the upper part of the dress into sleeves, but went with the whole arm naked, as well as the upper part of the breast.* This, as it will be remembered, was the costume of the goddesses in the Eddas, and it explains a provision, in that part of the early Frankish laws which was made for the protection of the female person. By the Salic law, if a free man squeezed a free woman's arm below the elbow, he was liable to a penalty of twelve hundred denarii; if it were above the elbow, the fine was raised to fourteen hundred denarii; and if he touched her breast, he was punished by a fine of eighteen hundred denarii. Women who required this protection evidently went with bare arms and bare breasts. We learn from the same laws that the Frankish women of this early period had their hair bound up on the head by a sort of cap or coif called an *obbo*, for one law provides that, "if any one derange a woman's hair, so that her obbo fall to the ground, he shall be condemned to a fine of fifteen solidi.†"

Tacitus praises highly the chastity of the German women, and assures us that the Germans were almost the only people among the barbarians who lived satisfied each with one wife, "except a very small number, who, not through licentiousness, but as a mark of nobility, seek to have many wives."‡ Polygamy we have seen, in the preceding chapter, among the Teutonic gods, and we shall soon find it prevailing among the Teutons who obtained possession of Gaul.

* "Nec alius feminis quam viris habitus, eosque purpura variant, partemque vestitus superioris in manicas non extendunt, nudæ brachia ac lacertos, sed et proxima pars pectoris patet."—Tacitus, "Germania," c. 17.

† "Si quis mulierem excapillaverit ut ei obbonis ad terra cadat, solidos xv. culpabilis judicetur."—"Lex Salica," c. 75.

‡ Nam prope soli barbarorum singulis uxoribus contenti sunt exceptis admodum paucis, qui non libidine sed ob nobilitatem plurimis nuptiis ambiuntur."—Tacitus, "Germania," c. 18.

Tacitus goes on to say that, among the Germans of his time, it was not the wife who brought a dower to the husband, but the husband who gave it to the wife. This was of course the *morgane-ghibu*, or morning-gift, the *morgen-gifu* of our Anglo-Saxon forefathers, a sort of marriage settlement, which was arranged on the eve of the marriage, but was given by the husband to the wife on the morning after the marriage was completed. It was, in itself, a sort of acknowledgement of woman's position. The historian adds that the parents and kindred were present to see that the terms of the gift were duly performed, and that it consisted not of objects intended for feminine indulgence, or for the gratification of female vanity, but of oxen, and a horse with its bridle, and a shield with spear and sword. These were the symbolical gifts—for symbolism prevails largely in the childhood of people—by which the wife was to understand that she was henceforth to consider herself the companion of her husband in his labours and dangers, to share with him his fortunes in peace and in war.

The Romans sought to conquer these Germans, and, during the flourishing period of the empire, they were successful, and drove them far back from the borders of Gaul; but as the Roman power in the west fell more and more into decline, the imperial government was first obliged to conciliate those whom it had formerly defied, and afterwards to rest upon their support. Captives taken in war were always treated as slaves, and at an early period Gaul began to receive large accessions of Teutonic servile population. Then the Romans adopted the policy of encouraging the German tribes to place colonies in the northern parts of Gaul, where the population was very thin, and, in return for the protection they received, they formed on this side the guard of the Roman province. They thus formed an extensive military colony, and the Romans knew them by the name of *læti*, in which we can hardly avoid recognizing the same word as the modern German *leute*, people. More than this, the Romans found that the Germans made better soldiers than any of their other barbarians, and they enlisted them into their armies and disciplined them. It was the impetuous charge of the German cohorts which decided the victory at Pharsalia. From this time it was the pride of successive emperors to possess German troops, and they made their body guards of German soldiers. After a while they formed the main force of the empire, and they were everywhere introduced into the offices of state, and even reached the imperial throne in the person of the Goth Maximinus, in the first half of the third century. In the fourth century the great officers of the

imperial court and army, and those who occupied the novel charges of counts of the domestics, dukes of the frontiers (*limites*), and masters of the soldiery (*magistri militiæ*), were almost all Franks, or Alemanni, or Goths, or Burgundians. Such a state of things could not constitute a permanent strength, and accordingly, the Western Empire presented a scene of continual turbulence, which encouraged the Teutonic peoples outside to seek their fortunes in it, while they began towards the fourth century to be pushed forward by the advance of masses of peoples of other races from behind. The Salian Franks, driven by the Saxons from their primitive establishment in the interior of Germany, established themselves in the country to the extreme north of Gaul, between the Scheldt and the Meuse, in the middle of the fourth century. But it was at the beginning of the century following that the great invasion of the Teutons began, and within a few years the whole of Gaul was divided in three great independent kingdoms, between the Franks, the Visigoths, and the Burgundians. In the first years of the sixth century, as the result of a long series of intrigues and wars, nearly the whole of Gaul fell under the domination of the Franks.

We can trace little of the social condition of the Teutonic conquerors of Gaul during the long period of the wars of invasion, and can only suppose that, as far at least as concerned the Franks, it differed not considerably from that described by Tacitus. No doubt the invaders were accompanied in their expeditions by their women and families, for we have a remarkable story in confirmation. One of the most formidable of the Frankish chieftains in the invasions of the earlier half of the fifth century was named Chlodio. His head quarters lay between Brussels and Louvaine. Having sent explorers to report upon the attractions of the country to the southward, he assembled the leaders of his people, caused himself to be elected their military leader, and plunged with the whole tribe into the forest of Charbonnière (*Carbonaria*), a part of the Ardennes. Issuing from the depths of the forest, these Franks suddenly made their appearance on the banks of the Scheldt, and after taking and destroying Tournai and Cambrai, and massacring their inhabitants, they overrun the country as far as the banks of the Somme. It was at the time when the great Aetius was commanding the Roman armies, and victoriously protecting the empire against the new invasions of the barbarians, and he hurried from Brittany, crossed the Somme, and found the Franks encamped at a place named by the Latin historians Helena, but supposed to be Lens in Artois. They were so far from anticipating the probability of an attack,

that they were busy celebrating, with barbaric grandeur, the marriage of one of their chieftains. A poet of Gaul, Sidonius Apollinaris, who wrote at this time, has left us a poem commemorating this event. He describes how, while the legions of Aetius and Majorianus were silently crossing the river, the hill beyond resounded with the noise of the nuptial festivities.

> "Fors ripæ colle propinquo
> Barbaricus resonabat hymen, Scythicisque choreis
> Nubebat flavo similis nova nupta marito."
> Sidon. Apollinar. "Panegyr. Majorian.," l. 219.

Suddenly the heads of the Roman legions appeared on the ground and the Franks were taken by surprise, and, after a short but vigorous resistance, they were defeated with great slaughter. They had made an attempt to carry off the provisions of the festival in their chariots, but both the bride and the feast fell into the hands of the victors. There, as the poet tells us, might be seen glittering on the waggons the scattered preparations for the feast of the barbaric nuptials, and the dishes thrown together pell-mell, and the dainties captured, and the great cauldrons crowned with sweet smelling garlands.

> "Plaustris rutilare videres
> Barbarici vaga festa tori, convictaque passim
> Fercula, captivasque dapes, cirroque madente
> Ferre coronatos redolentia serta lebetas."

Thus was Chlodio driven back in temporary disgrace upon his old hiding place in the forest of the Ardennes. The son of this Chlodio is called by the Latin chroniclers Meroveus, and by the French Mérovée, and he was the father of Clovis, who established the monarchy of the Franks, and from whom, as a Meroving, or son of Mérovée (it is the well-known Teutonic patronymic), the Frankish kings of the first race took the name of Merovingians.

The annals of the earlier period of Frankish history throw little light on the domestic character and condition of the people, and especially on that of female society. The Franks appear to have been distinguished from most of the other branches of the Teutonic race by their great ferocity and cruelty, and the story of their establishment in Gaul presents one continual and wearisome series of massacres and murders. We feel this painfully in reading through the narrative of Gregory of Tours, who seems as if he had only occupied himself with recording the crimes and vices of his countrymen and countrywomen. Women like Fredegond, and Brunehild, and many others whose names

are recorded in these annals, all of whom were women of high and lofty minds, appear as if born only to exercise a fatal influence on human society. Perhaps we must blame history itself, which at this period has delighted in recording that which is wicked, because it carried with it more thrilling interest, and while all these queens of evil influence are arresting our attention, we must not forget that it was a woman, Chlotild, the queen of Clovis, who led the Franks in the way to the truths of Christianity, and that it was another Frankish lady, Bertha, the daughter of king Charibert, who brought the truth of the Gospel from the land of the Franks into that of the Anglo-Saxons.

To use the phraseology of the modern French historical writers, the Franks, on their establishment in Gaul, came in face of two elements of civilization, the Roman element and the Christian element. They were barbarians in one point of view, and pagans in another. The Roman offered all the refinements of luxury, displayed splendid garments in rich materials, and dazzled with precious metals and jewels; the Christian urged the worthiness of poverty, the virtues of coarse apparel, and proscribed jewelry and ornament, except when used in the ceremonies or ornamentations of the church. The barbarians had soon begun to show a taste for Roman luxury, and, as they became acquainted with that people, they adopted more and more their manners and mode of life. The female sex, at least, adopted the Roman costume, and no longer appeared with naked arms and bosoms. The Roman ladies had themselves adopted some new fashions in dress, especially the *camisia,* from which word is derived the modern French word *chemise,* and which was introduced in the fourth century. It appears to have been an inner tunic, worn by women, and not laid aside at night; for Isidore gives the word, and tells us that it was derived from *cama,* a low Latin word for a bed, and that it was so called, "because we sleep in them in beds."* It was adopted by the Franks, and the name occurs in the Salic law. The camisia of queen Radegond (the saint) was embroidered with gold. The women, about the same time, brought into use a sort of buskins, or boots. The form of the tunic was modified by rounding it, and plaiting it in front.

The object of most importance to a woman was her hair, which in both sexes had in earlier times a political signification. A free man, or a free woman, always wore it long, and it was a grave

* "Camisias vocamus, quod in his dormimus in camis, id est, in stratis nostris."—Isidore.

offence to cut a woman's hair. By the law of the Burgundians, a free man who cut off the hair even of a woman who was a slave, was subject to a penalty, and a slave who cut off the hair of a free woman was punished by death. Unmarried girls were obliged to carry their hair loose without ornament, so that if a damsel was long unmarried, it was usual to say, "She remains in her hair," *remanet in capillo*. Married women might plait their hair, and adorn it with garlands, and with little fillets, called by the Franks *stapiones*, or *scapiones*—it is doubtful whether we ought to read the second letter as a *t* or a *c*.

With the Carlovingian period, the forms of society were becoming more firmly settled, but they underwent no radical change. The Roman type still prevailed in the female costume, and some further borrowings were made from the south, while whatever remained of the primitive dress of the Franks was rapidly disappearing. The usual dress of the women consisted of two tunics, of which the one underneath was longer and fitted closer than the other, and had close sleeves plaited at the wrist. The outer tunic was shorter and sat looser, with wide sleeves which reached only to the elbow. Bands of different colours adorned the extremities of this vestment, which appears always of a different colour from the under tunic. A band, or girdle, encircled the hips, and a head-cloth, which was often richly embroidered, covered the head and enveloped the shoulders, and sometimes descended almost to the ground. The hair was thus entirely concealed. This part of the dress was richly adorned, and often of very brilliant colours. Among new articles of dress introduced during the Carlovingian period, was one common to both sexes, called a cape (*capa*), a sort of mantle or cloak, which is said by the old writers to have been a revival of the Roman caracalla. It appears to have been susceptible of great display of ornament, for it was forbidden by the council of Metz in 888 on account of its extravagance.

The Franks were slow in receiving a taste for literature, and they have left us no pictorial representations of the female costume during the Merovingian period, and very little until rather late in that of the Carlovingian dynasty; and the illuminated manuscripts even of the latter period are all Bibles, or service books, or lives of saints, which contain only figures of sacred personages. Fortunately, however, these mediæval artists drew every body in the exact character and costume of their own time. The accompanying cut is a copy of an illuminated initial letter in a manuscript of the Latin Bible of the eight century, in which it forms one of the

letters of the first word of the Gospel of St. Luke. It was intended to represent the Visitation, and the two nimbuses show that the women are sacred personages, but they may be taken with equal truth for two Frankish ladies of the age of Charlemagne, embracing

each other. They are charming figures, dressed in the upper and under tunic as just described. The head-dresses are peculiar, and appear to be detached from the mantle or (perhaps) cape. In the figure to the left, the forepart of the hair is seen, divided in the middle, under the head-covering.

Our coloured plate is taken from a manuscript of the Latin Bible, written in the ninth century, and represents St. Jerome explaining the Holy Scriptures to the noble mother and daughter, Paula and Eustochia. They were two Roman ladies in whose house Jerome lived while he performed the duties of secretary to Pope Damasus. The lady nearest to Jerome is, by the richness of her costume, evidently Paula, and the next her daughter Eustochia, who had made a vow of virginity. The difference in the dress was intentional on the part of the illuminator, for we know that the dresses of married women were allowed to be much more rich, in material and ornament, than those of virgins. It may be well to

remark that the parts here coloured yellow, are gold in the original.

The next cut, also taken from a manuscript of the ninth century, represents two females, drest in the same costume. They wear, over the tunic, with the sleeves fitting tight to the wrist, a long robe which entirely covers the body, and has wide hanging sleeves.

There is a simplicity of character in the forms of this womanly costume, which gives a kind of imposing grace to the wearers. In this respect, they seem to have undergone no perceptible change during the whole Frankish period, but in richness of material and of jewelry they differed greatly. We hear the old writers speaking continually of the costly embroidery of the dresses of the Frankish ladies, which was usually of gold. Silks had been introduced among them from an early period of their settlement in Gaul, and other costly materials are mentioned. Silk and fringes of gold are often mentioned by Gregory of Tours. The clergy exceeded even the laity in this extravagance, and the ladies of the convents (as well as the ecclesiastics of the other sex), prided themselves on the richness of their dresses, and on the quantity of jewels with which they covered their persons. The great jeweller of the Franks—the patron of the jeweller's craft—was St. Eligius (or St. Eloi, as he is called in French). Yet these same ecclesiastics are always complaining of the extravagance and vanity of the laity. A preacher of Marseilles, in the fifteenth century, named Claudius Marius Victor, made a violent attack upon the vanities of Womankind in that city, in which he accuses them of painting their faces; and it is spoken of as the practice among

these Frankish ladies, at least at one period, to have their hair curled by means of curling irons. The extravagance in dress and in the toilette during the Carlovingian period appears to have been excessive.

Before the Germans came into Gaul, women had already been employed, on a tolerably large scale, in productive labour. Among the Germans themselves, in their primitive period, the women of the household were employed constantly in weaving the materials and in making garments for their husbands and families. It was the case also among the Romans in Italy, where a name derived from the Greek, gynæceum, was given to the room set apart for the females, in which they assembled to work. In course of time, public establishments were formed, for the manufacture of the same products, in which women were similarly employed, and to which they gave the same name of gynæcea. They were placed under the direction of matrons, but a considerable proportion of the work-women were slaves. They were early introduced into Gaul, where they formed the nuclei of the staple manufactures of particular localities, the materials being confined in some of them to flax, and in others to wool. Thus the Attrebates monopolised the manufacture of serge, and the same article still continues to be one of the staple manufactures of Amiens, which represents one of their principal cities. St. Jerome speaks of the fine texture of the stuffs made in his time at the civitas Atrebatum, or Arras. After the settlement of the Franks, the native industry revived in Gaul, and the gynæcea were re-established, apparently on an extensive scale, for they soon became very numerous. The historian Gregory, of Tours (lib. ix.), tells us how a lady of the court of Theodebert, charged with plotting against the king's life, had her face branded, and was in that condition sent to the village of Marlheim, to be there employed in turning the mill, and in preparing the meal necessary for the nourishment of the women who dwelt in the gynæceum which existed in that place. The great fairs of Gaul, such as that of St. Denis, were supplied with merchandise from the gynæcea, and Italy and other countries sought their products. A capitular of Dagobert, of the date of A.D. 630, fixes the punishment of a man who violated the person of one of the women of the gynæceum at a fine of six solidi of gold. Under the Carlovingians, the gynæcea remained in full activity. That at Stephanswert, belonging to Charlemagne's own domain, contained twenty-four women employed in fabricating vestments of woollen and linen, and of fillets for the legs. Charlemagne published several enactments relating

to these establishments. In the celebrated capitular of the year 800, he enumerates the various implements and other things which were to be supplied to these workwomen. The great emperor was so anxious that Womankind should be employed in productive labour, that he made his own daughters work in the domestic gynæceum as diligently as the other females.

After the time of Charlemagne, the character of the women of the gynæcea began to fall into discredit. The old laws for the protection of their virtue were apparently no longer carried into effect, and corruption found its way in among them. It became customary to speak of the inmates of the gynæceum as mere courtezans, until at length this was the only sense in which the word was used.

RAMBLES OF A NATURALIST.*

NATURALISTS make by far the best travellers; indeed, it is rare to find a book of travels worth reading unless it is written by a man of science, or specially relates to important matters of art. Our country produces abundance of adventurous spirits who journey through the most inhospitable regions, and explore the most inaccessible countries; but how few, even of those who take a leading place amongst geographical discoverers, are able to bring home any valuable information about the tribes they have seen, the fauna, the flora, or the geology of the lands they have passed through. Dr. Collingwood appears in the work before us as a very good specimen of a rambling naturalist. He visited the China seas in government vessels, and thus had little choice in the details of his route, and frequently had to hurry through localities in which he would gladly have lingered, but he seems to have made the best of his opportunities, and whether on land or sea was always on the look out for interesting facts.

At Aden he found a rich store of marine animals, including the *Bornella digitata*, a beautiful sea slug. Creatures of this sort, he tells us, preserve their colours well in glycerine, "though it unfits them for dissection." A week's voyage from Aden carried him to the cocoa-nut groves and cinnamon gardens of Ceylon, and during

* "Rambles of a Naturalist on the Shores and Waters of the China Sea. Being Observations in Natural History during a voyage to China, Formosa, Borneo, Singapore, etc., made in Her Majesty's vessels, in 1866 and 1867." By Cuthbert Collingwood, M.A., M.B. Oxon, F.L.S., etc. Murray.

the passage his observing faculties were never idle or without reward. The uneducated traveller complains of a sea voyage being tiresome, but Dr. Collingwood remarks that "scarcely a day passes without some addition to one's stock of information, whether it be a fish swimming in the sea, a bird winging the air, or some floating delicate animal which would seem least fitted to buffet with the waves." This is true enough; but the gist of the thing lies in the fact of "adding" to one's information, and when there is no information to add to, the case is a hopeless one. In the Royal Navy we occasionally hear of an officer sufficiently instructed to be able to see the things which nature abundantly places before him; but the tone of the service is unfavourable to intellectual exercise, and most officers prefer what Dr. Collingwood terms, "the dull and unendurable monotony" of an ignorant sea life, to the recreations of the man of science. "Not one in a thousand," he says, "troubles himself to observe what passes around him;" and the reason is too plain; the governing powers care little for the progress of knowledge, and the way not to get on in the service, is to be above the regulation standard in cultivation or usefulness.

At Penang our traveller was much struck with the caricature plant (*Justicia picta*), every leaf of which exhibits a series of caricatures of the human face of the most grotesque character. Hong Kong he describes as presenting a varied and beautiful appearance when approached from the sea; but he found the police of the little island badly managed, and walking in the Chinese quarter far from secure. From Hong Kong he steamed to Protas Island (N. L. 20° 42′, Long. 116° 43′ E.), mainly inhabited by gannets, who have an amazing faculty of devouring flying fish. When gorged with this prey, the birds sit on their nests, and if a stranger approaches they have to throw their stomachic cargo overboard before they can take to flight. The dinners ejected before Dr. Collingwood consisted of sometimes "six or seven flying fish, in other instances only three or four, and in two or three cases a squid or two intermixed with them." At this island the curious phenomenon occurred of rollers dashing in from the S.W., though the wind was N.E.; this effect was occasioned by a typhoon blowing 200 or 300 miles further south, and curving round.

At Formosa, Dr. Collingwood met with the leaping fish (*Boleopthalmus Boddaertii*), salamandrine-looking animals, scarcely distinguishable from the mud on which they rested, until, on being alarmed, they made off in a series of rapid leaps, which caused the sailors to denominate them "Jumping Johnnies." They were not

confined to muddy shores, but were also found "among smooth, rocky places, up which they climb with great skill by a series of leaps, wriggling and curving the tail at each leap in a contrary direction, that is right and left alternately."

The use of the towing-net in the Formosa Channel was very successful, catching, amongst other forms, the glassy crustacean, *Alima hyalina*, "whose carapace seemed carved from the purest crystal, with an elegance of sculpturing and a sharpness of outline not to be surpassed;" and glass crabs (Phyllosoma), whose flat leaf-like bodies, and long branched legs seemed made of fine plates of clear mica."

Several new species rewarded Dr. Collingwood's researches in this neighbourhood and in the adjacent islands. At Slut Island he found a small shrimp belonging to the genus Alpheus, "of a deep violet colour, and with a claw of a very remarkable construction." "I placed it," he says, "in a basin of water with a small crab, whose presence appeared violently to offend it. Whenever the crab came in contact with the shrimp, the latter produced a loud sound, the explanation of which is as follows: the shrimp possessed two chelæ or claws, on the right a large and stout one, and the left one long and slender. When irritated it opened the pincers of the large claw very wide, and then suddenly closed them with a startling jerk. When the claw was in contact with the bottom of the basin a sound was produced as though the basin were smartly struck, but when the claw was elevated in the water, the sound was like a snap of the finger, and the water was splashed in my face." He called it the Trigger Shrimp, from the action of this claw resembling that of a pistol trigger. If only put upon half-cock this trigger closed without noise. Dr. Collingwood adds, "The peculiar clicking apparatus is by no means unusual, and is shared by another genus, Alope."

As a good specimen of Dr. Collingwood's descriptive powers, we must quote the account of his visit to Fiery Cross Reef on a day when the sea was so calm that the ship's anchor could be distinctly seen sixty or seventy feet from the surface. Rowing over a two fathom patch, he allowed the boat to drift slowly and gazed on the sea treasures. "Glorious masses of living coral strewed the bottom; immense globular madrepores, vast overhanging mushroom-shaped expansions, complicated ramifications of interweaving branches, mingled with smaller and more delicate species—round, finger-shaped, horn-like and umbrella form—lay in wondrous confusion, and these painted with every shade of delicate and brilliant colouring—grass green, deep blue, bright yellow, pure white, rich buff, and more

sober brown—altogether forming a kaleidoscopic effect of form and colour unequalled by anything I ever beheld. Here and there was a large clam shell (Chama), wedged in between masses of coral, the gaping zig-zag mouth covered with the projecting mantle of the deepest Prussian blue; beds of dark purple long spined echini, and the thick black bodies of sea-cucumbers (Holothuriæ), varied the aspect of the sea bottom. In and out of these coral groves, like gorgeous birds in forest trees, swam the most beautifully coloured and grotesque fishes, some of an intense blue, others bright red, others yellow, black, salmon-coloured, and every colour of the rainbow, curiously barred and bounded and bearded."

Naturalists frequently observe curious and friendly relations subsisting between creatures that might be supposed hostile to each other. One of these is related by Dr. Collingwood as occurring on the Fiery Cross Reef, and also near Labuan, where he discovered a magnificent anemone two feet in diameter, with numerous deep blue tentacles, and in the cavity of this creature elegant fish, about six inches long, seemed to make their abode or at any rate to seek shelter.

Labuan was found by Dr. Collingwood to offer a host of interesting objects to the attention of the naturalist. He also reports sufficiently well of the Labuan coal to lead to the belief that if the company for working it had been properly managed, success would have been the result. At Labuan, Singapore, and Johore, Dr. Collingwood met with a new species of crab, the "Pill-maker." It is a small creature of its kind, many being no bigger than large peas. Its habit is to take up particles of sand in its claws, deposit them in a groove beneath the thorax, and subsequently to eject them as little pellets or pills from its mouth after having extracted what nutriment they may contain.

We are quite sure the specimens we have given of the "Naturalist's Rambles in the China Seas," will cause our readers to get the book for themselves, and they cannot fail to be much pleased with a work in which every page contains interesting and valuable matter.

THE STONE AGE IN SCANDINAVIA.*

Professor Nilsson, who holds a distinguished position in the University of Lund, in Sweden, was one of the first, if not the first, at least in his own country, to call attention to the subject of the stone implements of which so much has been said of late. He tells us in this book that his attention was first called to the subject as a boy, when, in his fondness for hunting, and in consequence of the smallness of his gun, he was obliged to form his own gun-flints, and when, in his hunting-excursions, he found from time to time flints which had been formed into implements by the hand of man in very remote ages. This became with him a subject of study, and ended in his giving to the world a book upon what he calls the stone age in Scandinavia, which is here translated by Sir John Lubbock. He seeks in it to classify the ancient stone implements found in the north, and preserved in the northern museums, and to explain their particular characteristics, and the object for which each was made. All this is very good; we take his explanations with some reserve—many we receive willingly, and some we are inclined to reject. But Professor Nilsson's book is now brought forward as part of an extensive theory which obliges us to regard it with a more critical eye.

We fully believe in a stone age in one sense of the word; that is, we believe that, at least in most parts of the world, there was a primeval period before the man who dwelt in it was in the possession of metals, and when, therefore, he was obliged to form the simple instruments which were necessary for assuring his existence, of stone, or bone, or wood, which ever was most useful or readiest to his hand. We are also of the same opinion with Professor Nilsson, that the population being at that period necessarily scattered thinly over the land, and occupied merely in obtaining wherewith to support life, these rude implements were made, not for war, but for purposes of peace—for killing animals, birds, and fishes, and for producing the imperfect manufactures which were necessary for clothing and shelter. And Professor Nilsson does not exactly restrict this to an age, but to a particular condition of civilization. But the error into which he appears to us to have fallen, and which is shared by the modern school

* "The Primitive Inhabitants of Scandinavia." By Sven Nilsson. Third Edition, revised by the Author, and Translated from his own Manuscript. Edited, with an Introduction, by Sir John Lubbock, Bart., F.R.S., etc. 8vo. London: Longmans.

of prehistoric archæologists generally, is that of supposing that this condition of society belongs only to the prehistoric period; in fact, in neglecting altogether the study of the subsequent periods, and assuming that society progresses uniformly, and that at any given period the same people is uniformly civilized. Now this was certainly not the case. If we take our own island as an example, and come so late as the Roman period, it cannot be doubted that there was a very great difference in artificial civilization in different parts, resulting, among other causes, from the want of that facility and rapidity of intercommunication which exists in more modern times. Metal was not to be had everywhere, and, wherever it was to be had, it was, no doubt, dear. There were, doubtless, wild parts of the island where metal implements were almost unknown, or where, when wanted, they could only be obtained after long delay, and at great expense; or, where implements of metal were well known, there was a part of the population which was too poor to purchase them. In either case, the people who were deficient in metal implements would be obliged to make them for themselves of stone, or any other material which was ready at hand, and, while fully acknowledging the existence of a (probably long) period, during which metals were entirely unknown, we still cannot admit that the existence of any particular stone implement is evidence that, at the time it was made, metals were unknown among the people who made it, or that the form of any particular stone implement is a proof of its age. On the contrary, Nilsson himself, and, as we believe, his translator and editor, Sir John Lubbock, labours to show that, in all ages of the world, from the so-called stone period to the time in which we are now living, among people who made their implements of stone, those made for the same purposes have always been similar in form; in other words that, either the natural ideas of uncivilized man, or the natural capability of the material used, led to a uniformity of form of implements intended for the same purposes, among all peoples in a certain state of civilization, at all periods. The evident result of this appears to us to be, that the form of a stone implement is no evidence whatever of the date to which it belongs, and leads us rather naturally to reject all these limits, and divisions, and subdivisions of periods. It is, if we may be allowed to use the phrase, Darwinism applied to stone implements.

There is another argument employed by Professor Nilsson in regard to these flint-implements which we consider especially weak. He pleads (see p. 192) that the earliest writers of history, strictly

authentic or only traditional, when telling of the wars so far back as even the mythic ages, make mention of no other weapons than those of metal, and therefore, he argues, as we understand him, the stone implements must have belonged to an age far anterior to those ages. To this argument we have to oppose, first, the argument furnished by Nilsson himself, that the stone implements were intended for the occupations of peace, and not for war, and, secondly, that, in battles which would find a place in the narrative of the historian, weapons of stone must have been used by a class of combatants who would have escaped historical notice. There is also another argument brought forward by Professor Nilsson, which, if accepted in all its force, would not amount to much, but which, as it appears very ingenious and specious, and is based upon the authority of the classical writers, requires some examination. It is that implements of stone were used by the ancients during the historic period in their religious ceremonies in a manner which showed it to be a traditionary reminiscence of that remote period when no implements were known but those of stone. As will be seen at once, the force of this argument is very small, but we will examine briefly the authorities upon which it is based, if merely to show the extreme carelessness with which writers on these subjects sometimes carry on their researches.

We have been led to look upon Professor Nilsson as possessed of a not very critical mind. When in England, two or three years ago, he published a paper on Stonehenge which it would have been more to his credit as an archæologist had it never been printed; and we cannot resist the temptation of examining, in the present volume, the authorities he brings from ancient writers to show the usage of flint knives for religious persons, "many instances of which," he says, "occur in history" (p. 97). He begins with the Old Testament. "When," he says, "the Jews journeyed out of Egypt, they were already well acquainted with iron, and yet Zipporah, the wife of Moses, circumcised her son with a sharp stone; and when Joshua again introduced the sacrament of circumcision, which had been forgotten during the wandering in the desert, he used the same instrument that had formerly been used for that purpose, namely, *the stone knife*." It appears that, in both these instances, the Hebrew words are of somewhat doubtful interpretation: whether they meant literally a knife made of stone (there is not a word about flint), or whether it was merely a phrase for a sharp knife, as it is translated in Joshua in most of the modern versions; and we are not aware, from other Jewish and biblical

authorities, that the Jews were in the habit, at known periods, of using stone knives for this purpose. If it were the case, it would only show a superstition in regard to the material used for this special purpose. It is not even suggested that circumcision was practised among the savages of the stone period. It is the same with the reference which Professor Nilsson makes to Herodotus, who, as he is here quoted, would give us to understand that in Egypt the practice of embalming was performed only with flint knives. This is not strictly the case: Herodotus says that iron was used in other parts of the process, but he adds that, in taking out the intestines, the Egyptian embalmers made an incision into the side with "an Ethiopian stone;" by which we are simply to understand that there was a superstition against touching the intestines with metal.

All this, it will be seen, has very little to do with the use of flint implements in prehistoric ages; but when Professor Nilsson comes to treat of the supposed traditions of the flint period in the classical ages, he is far less accurate. "The Phœnicians," he says, "likewise, after they had become acquainted with the use of metals, took sacred oaths at the altar in this manner. The person about to be sworn held *a lamb in the left hand, and a flint knife in the right,* vowing by gods and man that, if he broke the promise given, the god might slay him in the same way that he killed the lamb." The reference for this in the foot-note is, "Corn. Nep. *Hannib.*, edit. Kuchen.," quite indefinite enough to show that the writer had not been to the original to which he refers. In fact, we were quite surprised to think that a terse writer like Cornelius Nepos should have entered into all this detail, and we turn to his book, where, in his brief biography of Hannibal, chap. ii., he tells us of the famous oath against the Romans, which was taken by Hannibal from his father (it is Hannibal himself who tells the story) :—

"Simul me ad aram adduxit apud quam sacrificare instituerat, eamque, ceteris remotis, tenentem jurare jussit nunquam me in amicitia cum Romanis fore."

i.e., "At the same time he led me to the altar, at which he had prepared to offer sacrifice; and, having sent the others away, commanded me, with my hand on the altar, to swear that I would never enter into friendship with the Romans." It will be seen that all this story about the lamb and the stone knife is a mere dream;—in the authority referred to, there is no mention of either. The same story is told, in much the same terms, by Valerius Maximus, lib.

ix., c. 3, and the commentators state that the ancient manner of taking a solemn oath was by laying the hand upon the altar while swearing.

There is clearly nothing about a flint knife here; and the Professor is equally unhappy in his next quotation:—"When the Horatii and the Curiatii were to decide the fate of Rome and Alba by single combat, the Romans were no doubt well acquainted with weapons of metal; and yet Livy relates ('Histor.,' chap. i. 24) that the priest, at the sacrifice, killed the victim *with a flint knife;* and other instances might be mentioned." We turn to Livy, *loc. cit.*, and find the form of the oath as follows (the correct reference is, lib. i., c. 25):—

"Si prior defexit publico consilio, dolo malo, tu illo die, Jupiter, populum Romanum sic ferito, ut ego hunc porcum hic hodie feriam: tantoque magis ferito, quanto majus potes pollesque? Id ubi dixit, porcum saxo silice percussit."

It is the representative of Rome who takes the oath; he says, "should the Roman people break their faith, 'do thou, on that day, Jupiter, strike them thus as I this day strike this pig; and strike them as much more as thou hast the power and might to strike.' When he had said that, he struck the pig with a flint stone." There is, in all this, not a word about flint knives, or of any implements made of flint, but simply of a natural flint. Any superstitious feeling associated with it had regard to the material, and not to any form which was given to it; and we can well understand how the stone from which fire was drawn might be associated in the popular imagination with the divinity of Jupiter. Had Professor Nilsson gone to the grammarian Festus, he would have found (lib. x.) the whole matter explained, for this writer tells us that the oath made in early times in the name of Jupiter was performed as follows:—

"Silicem tenebant juraturi per Jovem hæc verba dicentes: Si sciens fallo, tum me Diespiter, salva urbe arceque, bonis ejiciat, ut ego hanc lapidem."

"Those who were going to swear by Jupiter, held in their hands a flint, saying these words: If knowingly I fail, then may Jupiter, preserving the town and the citadel, cast me out of my goods as I cast away this stone." It was no doubt a rough flint which the taker of the oath was expected to throw away—not *a flint knife.* We believe that these allusions in the classical writers to the superstitious usage of flints, have no relation whatever with the employment of flint implements in the ages when metal was unknown.

We regret to see a man whose name stands at any elevation in

science treating upon serious subjects in this loose manner. The only excuse which can be offered is that Professor Nilsson has taken his authorities at second hand, without looking at the originals, and that he believed anything that people said in their names; and unfortunately he does this in almost every case we meet with. We turn to p. 72, and we find him quoting an author well known to every one acquainted with the history of the middle ages. "Reference," says the Professor, "has also been made to a sentence in Wilh. von Poitier's 'Historia Guilhelmi Conquestris' (it should of course be *Conquestoris*), in which he says," etc. Professor Nilsson has taken his quotation at second-hand from a German writer, and he seems to be thinking, from the form in which he found it there, "Wilhelm von Poitier," that he was some German writer, instead of being a tolerably well-known Norman Poet, Guillaume de Poitiers.

We will say no more. We accept the translation of the book of Professor Nilsson for his arrangement and attempts at explaining the numerous classes of stone implements found in Scandinavia, whether belonging to a stone age, or to any other age; and especially for the interesting plates which accompany it. His accomplished translator and editor, Sir John Lubbock, has printed with it an Essay of his own, already well known, in which he explains the system of prehistoric ages, as he always does everything, elegantly, pleasantly, and plausibly; but at the same time we confess that we hesitate in accepting it. Our business here, however, is only with Professor Nilsson.

HAS THE SURFACE OF THE MOON ATTAINED ITS FINAL CONDITION?

BY W. R. BIRT, F.R.A.S.,

Secretary, British Association Moon Committee.

DURING at least the last eighty years this question has been mooted by most of those astronomers who, although in the *minority* as regards the affirmative, have perhaps been more actively engaged in scrutinizing the moon's surface. Schröter, at the close of the last century, and Schmidt, in our own time, have announced changes in the appearances and characters of certain objects; new craters in some cases, the obscuration and disappearance of well-known objects in others. The announcement by Schmidt, towards the close of the year 1866, that the crater Linné had disappeared, has directed the attention of astronomers afresh to the subject. Schmidt, from his own observations during twenty-five years, appears to be confident that the crater has *really* undergone a physical change; while other astronomers, who, perhaps have not given the attention to the moon's surface which Schmidt has—from observations continued through a lunation or two—have concluded that Linné is still in its former condition, and have suggested that any pretended changes ought to be explained on the ground of observations which have been made under unfavourable circumstanses, combined with inexactitude in former drawings of the crater.

Among the objects recorded by Schröter are to be found, although but rarely, certain *black* spots, such as the fine black spot seen by Buckingham and Schmidt on Linné in December, 1866. Similar spots have been seen by our countryman Dawes, three particularly near Sulpicius Gallus, which were perfectly distinct, nearly round, and sharply defined, on June 10, 1867, but were nowhere to be found on June 13, 1867. This is not surprising, for if they should be small pits in a roughened surface, they may remain effectually concealed until two coincident circumstances recur, viz., the visual angle opening a channel for the rays amongst small eminences, and the direction of the terminator allowing the shadows to fall in the same way as on the 10th of June, 1867. The latter will not occur until the same period of the next lunar year, and depends on the distance of the moon's node from the sun, or

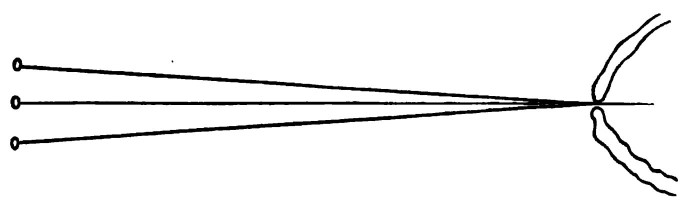
$\odot$ — ☊; for when this quantity $= 0°$, or the longitude of the node and sun, as seen from the moon, are equal, it is the spring equinox to the northern hemisphere of the moon. The visual angle has a longer period, which is dependent on a similar coincidence of the two librations in latitude and longitude. In addition to these circumstances, we have *the different conditions of our own atmosphere,* tending in no small degree to lead the mind to suspect change of a *physical character* when there has been *no* change, but only a concealment, as in a landscape, where a distant object is hidden by one not quite so remote; and this is not all, for we are really so very much unacquainted with the nature of the moon's surface, that it is impossible to say what may be in existence tending to produce an *apparent* change, while the object is in precisely the same state as when it was observed with great clearness and precision. Under such circumstances, it is of great importance to withhold our acquiescence in any supposed change *until proven.*

Astronomers are divided as to the real condition of the surface of our satellite, some regarding it in a state of "fixity," others in a state of "change." It must be in either the one or the other. The idea of "fixity" cannot be better expressed than in the language of Nasmyth (who, we all know, has paid great attention to the subject), as follows:—"In my opinion, no changes whatsoever are in progress on the moon—*no water, no atmosphere;* therefore, no *soil,* no vegetation, and no inhabitants."—(Crampton's "Lunar World," p. 132.) No language can so fully express the idea of *absolute fixity* than this. On the other hand, *change* runs through a variety of gradations, from the "slight cracking," as Mr. Nasmyth says, "from the contraction or expansion of the rocks, as the fierce heat of the sun gives way to, or succeeds, the terrible intensity of the cold, that will come on so rapidly, as soon as the sun has set, to the part in question * * the only agent of disintegration now in operation on the moon" (Crampton's "Lunar World," p. 136)—to the depression of a large tract of land as the plain east of Straight Wall, or the elevation of a mountain, as "Jorullo," which, it is right to say, Mr. Nasmyth regards as having ceased on the moon myriads of ages ago. If the moon's surface be really subject to change, it appears, from a comparison of observations on record, to have been indeed very slight. No observer, except Schmidt, has announced the detection of "change," and his instance is seriously and gravely questioned. To *prove* change on the moon's surface is extremely difficult; the impediments are very numerous, arising from libration, which constantly alters the visual angle; from the

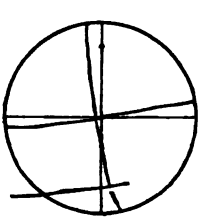
oscillations of the equator of illumination, which materially affect the appearance of certain objects, rendering them sufficiently *dark* in *summer* and *light* in *winter* to arrest the attention, it may be, as *new objects;* from imperfection in the transparency; and from agitation of our own atmosphere rendering objects so indistinct at times as considerably to alter the appearance of some, and effectually to conceal others which, on a night of extremely *fine* definition stand out with marvellous distinctness; from irradiation, and circumstances which cannot be referred to either of the above heads, rendering, as I saw with Mr. Knott's Alvan Clark, of $7\frac{1}{3}$-inches aperture, *under admirable definition,* FOUR very conspicuous objects, which I well knew, a *blurred mass,* while the neighbouring objects were beautifully distinct. All these are very serious obstacles to our endeavours to get at "change;" but, I apprehend, to prove "fixity" is still more difficult. It is true that, generally speaking, we recognize those objects with which we are familiar as presenting the same appearance, modified only by those circumstances which we know must affect them; but has any observer of the moon's surface, in preceding years or at present, so thoroughly *scanned* the surface, *jotted down* the positions of the objects, *measured* and *recorded* the appearance of ALL that can be seen, that such an observer can say, from *observation,* past and present, that any ONE particular object is *exactly* and *really* in the same physical state as when Galileo first beheld the moon through his wondrous tube—let alone the countless thousands of mountains, pits, craters, plains, and other objects, which we know have not yet been examined? If Mr. Nasmyth's view be correct, that "*although now almost gone by,* the only agent now in operation as a disintegrator is that of the alternate contraction and expansion of the rocks by heat and cold," *some change* must be taking place which, while invisible to, and probably beyond detection by us, is nevertheless real. Consequently, the idea of "fixity" is invalidated, and we are encouraged and urged onward to persevere in inquiring into the *present* state of the moon's surface, that our labours may be of advantage to those who succeed.

It has been suggested that fallacy may be detected by *noticing the recurrence of the same appearance which had been supposed to have passed away, or to have been superseded by other appearances.* There are, however, phenomena presented on the moon's surface indicating "form" which are very seldom seen; indeed, it may be many *years* before we may be able again to catch them. For example, the remarkable stream of light crossing "Plato" in the

direction of the longer axis, which was seen by Bianchini, August 16, 1725, and of which he gave a drawing in his work, "Hesperi et Phosphori." This drawing was copied by Schröter. This stream of light has not, to my knowledge, been seen *since*. From my own observations of Plato, which are not few, I am inclined to consider that this stream of light was thrown through a depression in the west wall which is very apparent, and which I have seen many times, even as late as the 11th of June, 1867. If the opening be *very narrow*, it is only at the time when the direction of the terminator forms a right angle with the length of the gorge that the stream of



light is thrown across the plain. At all other times it is thrown either towards the N. or S. walls, and may be very soon intercepted by the N. or S. walls of the gorge. If the west wall of Plato be *precisely* in the same state as when Bianchini observed this light streak, then we ought to have it in *those lunar years* when the angle which the morning terminator makes with the meridian *as it crosses the* W *edge of Plato* is the complement of the angle which the direction of the gorge makes with the meridian. Consequently, the time of its appearance is strictly within our power to calculate; and for this purpose the formula is very simple, the azimuth, as regards the lunar equator, being known. *Supposing* the opening to be slightly N. of a parallel, *i.e.*, the direction is very slightly N. of W. and S. of E., and makes an angle of 89° with the meridian. Bianchini's stream will fall across Plato when



the value of $\odot - \Omega = 41^\circ \pm$, *i.e.*, provided the supposition be correct; but as this value occurs but once in the lunar year, between the spring equinox and summer solstice, northern hemisphere, and more frequently at times when the sun *is not rising upon Plato*, it is clear that Bianchini's stream can very rarely occur, and from the earth can be still more rarely seen. It follows, therefore, that it is not safe to regard the *total absence of a pheno-*

menon, even during an interval of 141 years, as indicating real change.

The only way, as it appears to me, to test an alleged change such as we have in the phenomena of Linné, is to collect and well weigh all the information bearing on the subject, both *ancient* and *modern*. Hitherto, the progress of selenography as depending on the comparison of drawings for fixing characters, or for determining change whether they be early or recent, has signally failed. I speak more of my own experience, at the same time with regard to others I am unable to lay my hand on any delineations of the moon's surface that would satisfy me, from a comparison of them *alone*, that *real* change has taken place. All the circumstances above alluded to are so many drawbacks to a true scientific determination of change. Under these adverse and almost disheartening circumstances we have, it may be, a clue to the unravelling of some of the mysterious phenomena occurring on the moon's surface; that which has been attended with such signal success in the investigation of binary stellar systems:—viz. measurement—may be employed with advantage on the moon's surface. Already it has enabled us to determine with equal accuracy as on the earth, the positions, heights, and depths of objects; and a *judicious* application of it to size may still further help us. I am not aware how far B. and M.'s and Lohrmann's measures for size can be depended on, the extents of objects are very freely scattered over both works, and B. and M. give, on pp. 88, 89 of "Der Mond," the formulæ, with an example of computation, also a table of determinations. Be this as it may, we are certainly able to obtain measures, accompanied by a description of the objects measured, which treated in a certain way, are likely to help us in our investigations. For very *close* determinations, each measure must be submitted to a somewhat troublesome computation, and this is by no means desirable, as small differences will inevitably be mixed up with the circumstances before mentioned. To decide on *real* change, we must have *salient* and *large* differences. Now we know that at the centre of the moon one second of arc covers a certain linear space, according to my computation, 1·1585 English miles, or 6116·7 English feet. At any given angular distance from the centre, 1·″0 will cover a *greater* space in the proportion of the secant of the angle. If, therefore, we measure the diameter of an object on the radius from the moon's centre, it is not difficult to calculate the extent of the measured line in English feet, and we can thus express the size in English feet and seconds of arc. Both Lohrmann and B. and M.

give the diameters of craters in geographical miles of 3807·1 toises each, which are equivalent to 24,344 English feet, and we have Schmidt's value for Linné 1·5, and B. and M.'s 1·4 geographical miles; these values subtend respectively 5·″17 and 4·″83 at the position of Linné on the radius at mean distance. The value of 1·″0 = 7056·6 English feet. On Oct. 18, 1866, Schmidt considered the whitish cloud which he found in the place of Linné, to be two geographical miles in extent; and on Dec. 27, 1866, only 2000 toises. In Dec. 1866, on the 15, 18, 19, 21; and on Jan. 14, 1867, I measured the white cloud on Linné, in a direction *at right angles to the parallel.* The measures varied from 6·″75 to 11·″61 or 4·″86, a greater quantity than can reasonably be ascribed to errors of observation. In July, 1867, measures made very carefully, varied from 5·″33 to 7·″0 in three days. Mr. Buckingham, on March 14, 1867, found the cloud 6·″0 in diameter. Combining these (of course involving the small errors arising from libration $\pm$), we have a series of diameters referred to the radius varying from 12,790 to 81,920 English feet—a very large difference, and certainly unconnected with libration. The difference in seconds = 9·″80, which is very much greater than the difference of 25 sets of measures of Dionysius—viz. 4·″67. This difference in the measures of craters appears by no means to be a rare occurrence. Now, what does this depend upon? The measures of the white cloud "Linné" were made so near each other in Dec., 1866, and in July, 1867, that the varying distance of the moon could not produce so great a difference. It is difficult to conceive that the increasing or decreasing altitude of the sun could *alter the extent* of a reflective surface, although it would the intensity. Again, unsteadiness in the state of our atmosphere would tend to enlarge the measures, but the difference of 4·″5 in three days can hardly be referred to this cause. The series appears to point, 1°, to errors of observation or reading; 2°, to the state of our own atmosphere; or 3°, to an *increased* and *decreasing* extent of matter of a greater reflective power than the surface of the *mare.*

Were all the observations made by myself, I might well distrust them, but when Schmidt and Buckingham agree to within 1·″0, and I agree with Huggins to 0·″008, some of mine at least come into the category, and, with the exception of Schmidt's value of Dec. 27, 1867, and a measure by Joynson of 4·″42 on January 3, 1868, they give a *larger* extent for the white cloud than Lohrmann and B. and M. gave for the crater. The small crater of Secchi, which he estimated at $\frac{1}{3}$ of a second, with the small hill and black

point estimated by Schmidt at 1900 and 1700 English feet, would subtend an angle of about ¼ of a second. But Respighi makes the small crater 4·″0. Gathering up the results, we have four separate objects on record. The crater (B. and M.) (Grube, Lohrmann), 1087 English feet deep, having a mean diameter of 35,265 English feet; the whitish cloud (weisse wolke, of Schmidt), the largest measured diameter being 81,932 English feet, and the smallest 31,190 English feet. Schmidt's estimation on Dec. 27 was much smaller, viz., 12,790 English feet. The little hill of Schmidt, seen by Buckingham and others, of about 1900 English feet in diameter; and the little crater of Secchi, of about 2000 English feet in diameter, which has been seen by several observers.

How are these different objects to be treated? The questions that suggest themselves to my mind are numerous. Did the state of our atmosphere in Greece so effectually conceal the white hill and black point, that Schmidt did not see them during October and November? Was the state of our atmosphere so greatly improved in April that the little crater was seen more distinctly then than at any other time? Has a deep crater, which B. and M. probably measured, and to which *three* selenographers have assigned a diameter over one geographical mile (German), been so affected by some remarkable influence during the last few months, as to present the appearance of a hill or dot, and afterwards of a small crater of less than its seventeenth part. Has the older crater during a period of short duration shown itself—*still contracted in size*—to Respighi, while other observers speak of it as small. If it appears *smaller to us* in 1867 than it did to Lohrmann and B. and M. in 1823 and 1831, it is exceedingly important to ascertain the nature of the cause that is capable of so materially contracting it *in appearance*, while it remains precisely of the same size. If, on the other hand, the crater was never larger than it at present appears to us, it is quite as important to *prove* that B. and M. and Lohrmann were mistaken! Respighi says on this point: "Que si la carte lunaire de MM. Beer et Mädler donne au cratère des dimensions plus grande, ou doit l'attribuer a l'inexactitude du dessin inexactitude dont ou pourrait produire d'autres exemples bien plus manifestes; ou est d'autant plus fondé à le faire que dans le cas actuel il s'agit d'un objet représenté par un signe de convention plutôt que par un dessin veritable."

Another question suggests itself: What influence has produced the appearance of the whitish cloud seen on one occasion more than

twice as large as the crater recorded by Lohrmann and B. and M. Schmidt, in his paper on Linné, gives no observations between 1843, August 17, and 1866, Oct. 16. In 1842, July 14, Linné was drawn "als sehr kleiner crater." It is therefore very uncertain when the appearance recorded by Schmidt first occurred. On the other hand, it is quite certain that between 1866, Oct. 16, and the present date (June 28, 1866), we have enough on record to *prove* the *present state of Linné*, viz., the *larger* shallow crater, with the smaller crater within it—a state of things not at all hinted at in the earlier records. The whitish cloud is still existing, and is a very proper object for measurement in the present state of affairs. The black dot may or may not be seen again.* It appears to have been described as a crater, and a diameter of 4·″0 assigned to it. Its permanence, or fugitive character, it is very important to determine; but nothing I apprehend can settle the question but close and unremitting observation, which Linné has been the subject of since Schmidt's announcement.

On April 11, May 11, and June 10, I carefully examined Linné, and could find nothing like a crater with apertures of 4¼ and 8¼ inches.

* The small crater was seen and measured by Mr. Joynson on January 3, 1868. Its diameter was 1·″223, which is 0·″487 less than Mr. Huggins's measure of it on July 9, 1867.

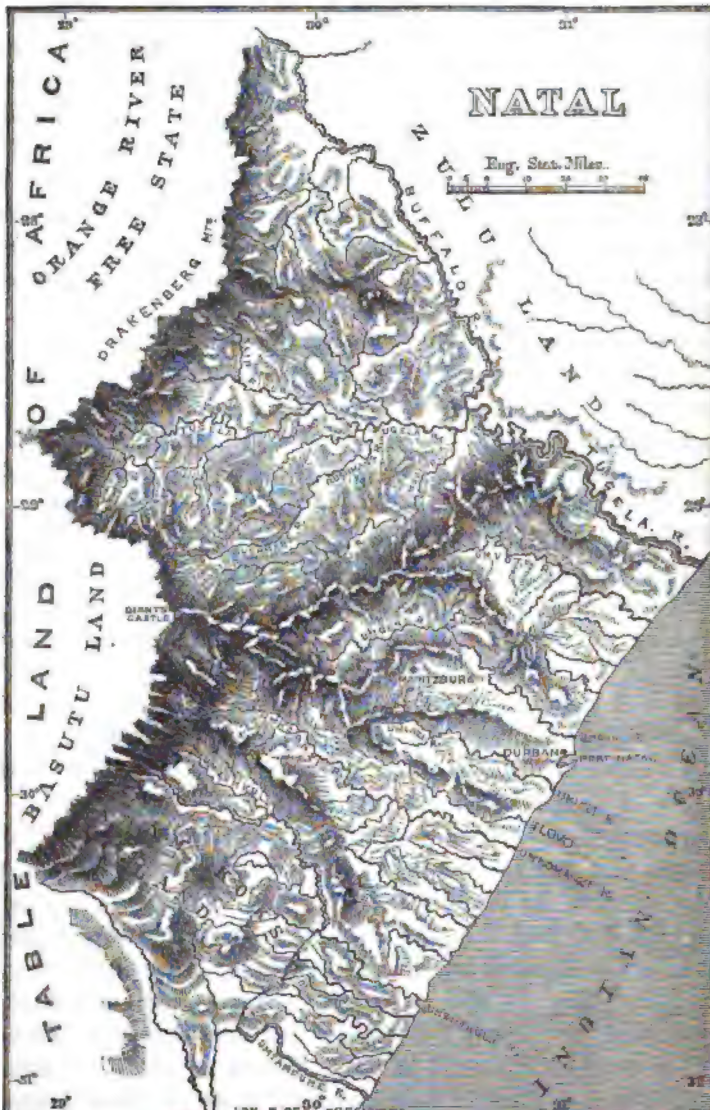
THE THUNDER-STORMS OF NATAL.

(*With a Map and a Plate.*)

THERE is a small colonial land, belonging to England, and furnishing a field for the growing enterprise of a now increasing band of English settlers, which lies in the further hemisphere of the earth, reaching at one point to within but little more than 200 miles of the Southern Tropic, where the scorching sun shines vertically down upon the ground at noon at the period of midsummer; but which, nevertheless, has a yearly mean temperature that, even on the low sea-coast, does not exceed 68° of the heat-scale of Fahrenheit, and an absolute temperature that, excepting upon rare occasions, when a hot land-wind, or Sirocco, prevails for a brief period, does not at the warmest period of the day exceed the heat experienced in an English summer. In this favoured land the sugar-cane, evergreen coffee, tobacco and cotton, Indian corn, the pine-apple, the banana, and the orange are at home; and so also, strange to say, are cattle, sheep, and horses, the grain and root-crops, and to a considerable extent, the trees, vegetables, and fruits of temperate Europe.

This remarkable result is brought about by the instrumentality of a power that is ordinarily deemed one of the most terrible of nature's agencies, but which here stands so manifestly stamped with a beneficent character and function, that it is literally stripped of its terrors and welcomed, day after day, nay almost courted, for the good it brings. The writer of this memoir, indeed, as having occupied somewhat the unfortunately responsible position of a clerk of the weather and, as it were, Rain-doctor, out in the land of which he is about to speak, has actually found himself on not rare occasions, exposed to the unmistakeable and very imperfectly repressed reproach of a partner and companion—who certainly had no particular affection for thunder and lightning in old days in England, before she had had the advantage of making its acquaintance in South Africa—because the afternoon thunder-storm lingered a little behind its time. It will be apparent, then, from this incidental avowal, that the clerk of the weather and Rain-doctor in question is about to describe this agent in the operations of nature, the thunder-storm, as it is capable of being studied in its favourite haunt and home, among the green hills of South-Eastern Africa, where it ordinarily assumes its grandest and most majestic aspect, while performing its beneficent office.

It is matter of familiar knowledge that the conversion of invisible


NATAL
Eng. Stat. Miles.
TABLE LAND OF AFRICA
ORANGE RIVER FREE STATE
DRAKENBERG MTS.
BASUTU LAND
ZULU LAND
BUFFALO
TUGELA R.
GIANTS CASTLE
DURBAN
PORT NATAL
INDIAN OCEAN
LON. E. OF GREENWICH

vapour into visible mist and palpable water, is nature's main plan for the development or manufacture, so to speak, of electrical force. Energy, or power, that had been productively engaged in sustaining the watery principle in its more refined, elastic, and invisible state, is deprived of its occupation, and turned loose upon the world to find other work to do, when its invisible charge is taken from its hold and converted into visible cloud or rain; and can often be so observed in its unoccupied condition, on the outlook for another engagement. If the condensation of invisible vapour into visible mist be gradual and slow, the force set free has time and opportunity to scatter itself gently about, until it can secure fresh occupation in a quiet way. But if the condensation is rapid and great, the emancipated energy gathers too quickly, and in too large amount, for this quiet dispersion, and so, from time to time, bursts forth in overflowing power as vivid lightning. It follows, then, from this being the mode in which what is called free electricity is generated in the regions of the air, that in all places where the condensation of invisible vapour into visible mist and cloud is carried on in a slow and orderly way, the great visible manifestations of electrical disturbance, known as thunder-storms, are rarely seen; but in all places where the condensation is prone to be rapid and paroxysmal, thunder-storms are of frequent occurrence. Conditions which allow great quantities of invisible vapour, floating or streaming in the upper regions of the air, to be *suddenly* thrown down to the earth as palpable water, or as heavy rain, are then properly the material machinery which is employed by nature in the evolution of this class of tempestuous disturbance.

These conditions are provided in a very remarkable and interesting way in that portion of South-Eastern Africa in which the colony of Natal is placed, and hence Natal is a land of thunder and lightning.

This young colony of Great Britain stands on the south-eastern border of Africa, 800 miles beyond the Cape of Good Hope, and looking out on to the sunny Indian Ocean by a coast-line of about 150 miles long, that lies between the 29th and 32nd parallels of southern latitude. It is a strip of territory about one-third the size of England. Its landward frontier lies at a varying distance of from 120 to 160 miles from the sea. But this landward frontier is properly the broken edge of that central table-land of the African continent, whose surface is reared, in round numbers, some 6000 feet above the ocean. The strip of territory which constitutes the colony is in reality but a portion of the bevelled or sloping rim by

which the great continental table subsides to the sea; the edge where the upper pavement, or layer of veneer, has been chipped away, baring the foundation-substance of the structure.

This bevelled rim is accordingly not a smooth and evenly laid slope, but a rugged surface of valleys and hills subsiding gradually from the high mountain frontier to the sea in successive rises and falls, which wind, and twist, and branch in all conceivable directions. From one point of the mountain frontier, where it forms a salient angle towards the colony, there comes forth a subordinate but still very prominent ridge, which thenceforth becomes the key to the maze of hills, and to the configuration of the lower land. This ridge extends, as a great central system of highlands, quite across the middle of the colony, forming a mass of land which rises, at a distance of not more than seventy miles from the sea, above one mile high. From this central highland other derived ridges finger and fringe down to the sea, with distinct water-sheds and rivers lying between the several fingers. But northwards, and beyond the great highland, the land declines into a kind of broad basin, which is drained by a single large river system, and which is in reality a *coal-basin*. All these very interesting and, as we have presently to see, pertinent characteristics of the land, are pictorially represented in the accompanying little sketch, where the central highland is seen coming out from the Giant's Castle-point of the Drakenberg frontier, and fingering down to the sea, with the great rivers and smaller streams, from the Umvoti to the Ilovo, draining down between the fingers. And where the large upland basin of the single river, the Tugela, is also shown northward of the central highland.

Now, as the eye rests upon this little miniature representation of the physical configuration of Natal, it will be very easy to realize the fact that, broken and varied as the general surface of the country is everywhere, there is nevertheless a general rise, in advancing inland from the Indian Ocean, along a slope that has the comparatively steep gradient of one in seventy, until the culminating central highland is passed. It is very much indeed as if Ben Nevis were made one-fifth higher than it is, and stretched out across the entire breadths of the counties of Oxford, Buckinghamshire, and Hertford; and were then sloped and ribbed away to the shores of the English Channel by an irregular succession of abrupt and broken falls. Such is the country which lies on the shore of the Indian Ocean, almost under the blaze of a tropical sun, and which, for most beneficent reasons and uses, is made into a manufactory of thunder-storms.

The Valley of the River Umgeni from Table Mountain.

It has been already premised that the first great requisite—the prime raw material which has to be supplied in large abundance, in this manufacture—is invisible vapour capable of being turned, at a minute's notice, into copious deposits of palpable mist and water. Now, this raw material is drawn in the greatest abundance from a never-failing source close at hand, and the business of the supply is managed in this way. The sun, shining down day after day on the broad slope of land which is inclined from the mountains to the sea, heats the air in that position very considerably, and this most especially in the season of summer, when the sunshine falls most directly on the ground, and when the days are the longest. The heated air necessarily acquires a strong tendency to rise along the slope. In other words, it is *driven in* by the superior pressure of the cooler and heavier air resting over the less heated sea. A strong and steady breeze thus blows from the sea up over the land. This tendency to a sea-breeze is also confirmed and increased, for a considerable portion of the year by the further fact that in these latitudes of the earth the great trade-wind movement to some degree affects the air, and that the general set of the southern trade-wind is in the same direction. The characteristic streams of cumulus cloud, which so remarkably distinguish the trade-wind sky over the broad ocean, may at certain periods of the year, when the southern trade-wind stretches farthest to the south, be seen sweeping in from the ocean over the green hills of Natal.

From the combined operation of these two strong influences, it happens that, four times out of five, when the direction of the wind is noted, it is found to be from the south-east, streaming in from the broad sea to the land. This frequent and prevalent sea-breeze is most steady in the middle and after part of the day, and most interrupted after the middle of the night, when the air over the land is least affected by the warmth of the sunshine. Now, a sea-breeze is notoriously a moist one. It comes in from the ocean naturally laden with the heaviest load of moisture that it is able to sustain in the circumstances. If it arrived with its burthen at a spot where it had immediately to encounter diminished temperature on striking the land, its burthen would appear as visible or palpable mist and rain. In the instance under consideration, this is not the case. It arrives at land that is, at least during the day, warmer than the sea. Consequently, no visible moisture is immediately thrown down. The air, as it moves along up over the land, for a long time still sustains its heavy load of vapour in a transparent

and invisible condition. At length, however, as it moves along over the heated ground, it becomes so warm that its upward movement is largely accelerated, and it takes to mounting somewhat after the fashion of the strong up-cast in the shaft of a heated chimney, or of the ascent of a very light balloon. In the higher regions of the atmosphere, it finds itself suddenly freed from a considerable portion of the overlying weight which it has previously had to bear. Freed from this weight it expands, and by the mere act of expansion is cooled and chilled. Very often this, too, occurs simultaneously with the decline of the afternoon's sun, and the withdrawal of the direct warmth of the sunshine. The result is the sudden and very copious condensation of invisible vapour, in these high regions of the air, into tangible mist and moisture. The sky is suddenly piled up with dense clouds, which grow heavier and thicker until rain streams from the black canopy to the ground, and the electrical force, which is set free by the act of condensation much too rapidly and abundantly to be able to be quietly dissipated, flashes forth in brilliant lightning.

Such is the material and mechanical process adopted in the manufacture of the thunder-storm.

The operation of this remarkable proceeding is so constant and steady in Natal, that, in a period of eight years' observation, there were 408 thunder-storms in the city of Maritzburg; or, to speak more exactly, 408 days on which thunder-storms occurred, for not unfrequently there are several storms following at brief intervals on the same day. There were also ninety-six other days on which storms were prevailing within ten miles, so that lightning could be seen or thunder heard from the city. This, however, it must be understood, does not really furnish a full and sufficient tally of the prevalence of the thunder-storm, for the phenomenon is always of a fitful and restricted character. It sweeps along over a limited range of country, leaving intervals unvisited by its presence; so that it by no means follows that when any one spot, which is taken as a fixed point or station of observation, is without a storm for twenty-four hours, there are not places within fifty miles to the right or to the left where the storm is putting in a vigorous appearance. Very commonly distinct storms are raging simultaneously at different places, with void and fine weather intervals between. Taking this peculiarity into account, it is quite within the bounds of reasonable probability that there are storms somewhere in Natal almost daily during the hottest period of the year. If any one place, like the city of Maritzburg, is alone considered, the storm

may be confidently looked for at that period on each third afternoon upon an average.

The thunder-storm generally occurs in Natal immediately after a comparatively low barometer, when the mercury just begins to rise. The sea-breeze is, more or less, intermitted as it bursts, but sets in immediately afterwards with renewed energy and vigour. The clouds are first seen to gather about the tops of the highest hills as rolling caps of white and grey vapour, and then to extend themselves rapidly downwards and seawards. The storms observe earlier hours in the higher regions and among the mountains. At Maritzburg, 2000 feet above, and fifty-four miles from the sea, their usual time is from three or four in the afternoon to the early evening. A morning storm is almost an unknown occurrence, and night storms are comparatively rare.

At Maritzburg the storms nearly always sweep down from the higher hill-region lying towards the west or north-west; mist rolls down from the hills early in the afternoon, after a bright clear morning; the sun is concealed; light rain begins to fall; distant thunder is heard, which resounds at short intervals nearer and nearer; and then the tempest sweeps by, with an accompaniment of gusty wind and sheets of driving rain; the lightning flashing down, now here, now there, in broad vibrating streams, and the thunder at this time bursting with a crash, which, after a perceptible pause, "leaps" into a reverberating and subsiding roll. The actual fury of the storm is, however, very short-lived; a stream of blue or red lightning, five seconds before a rolling thunder-peal to the west; a blinding flash and a deafening crash almost simultaneous, and seemingly in the next garden or field; another lightning streak, ten seconds before a loud thunder-peal, quivering down in the dark cloud to the east, and the storm is gone on its rapid journey to the sea; and can be traced in its retreating track, after the sound of the thunder is lost, by the corruscations of lightning that illuminate the dark sky at repeated intervals. This is one of the very remarkable, and it may be added agreeable, traits of the tropical thunder-storm, its extremely lively movement. It is incapable of loitering or lingering; it is coming, and here, and gone, almost as soon as it has drawn the attention. It is a matter of the rarest occurrence to have it hang and brood over one place, as it sometimes does in England, for any protracted period. The writer has recorded, as an altogether exceptional instance, that on the 20th of October, 1863, there were six tolerably close discharges within ten minutes.

The rain, however, does not cease when the brunt of the storm

is passed; it continues to fall, but with less violence and vigour, commonly for two or three hours. It then stops, but the air does not clear; the sky remains shrouded in hanging mist until far into the night, when the veil is at last torn asunder in preparation for the morning sunshine. At that period the stars appear with a defined brilliancy and glory that they never wear upon any other occasion. It is no uncommon thing at such times in Maritzburg, which is 2000 feet above the sea-level, to see with the unaided eye the entire heavens, with the exception of the blank dark patch around the southern pole, literally scintillating with "star-dust," as the scattered hosts of seventh-magnitude stars advance into visibility through the clear, thin atmosphere.

The electric discharges of the thunder-storms of Natal are unquestionably of very high intensity. This is immediately expressed to the eye in a noteworthy way. The discharge is certainly, in the greater number of instances, from the over-burthened cloud to the earth; the track of bright light is continually seen ploughing its swift way down through the dark masses of the cloud until it is lost in the close neighbourhood of the ground; and there is this very remarkable peculiarity in the aspect of the track as it does so. It appears to the eye as a *broad ribbon* rather than an immeasurable line, as the electric discharge is generally seen in England. At the first glance it seems, too, to make its leap with more deliberation; it remains for a perceptible and appreciable instant graven upon the sky. More close and careful observation shows, however, that during this appreciable instant the luminous track is not steady. It quivers most distinctly, and it is this quivering that makes it apparently linger. This is certainly due to there being a rapid series of discharges following each other in succession along the same track. The intensely-charged cloud is relieved by successive leaps. The "ribbon-like" *breadth* of the electrical track is due to the very wide spaces of air that are involved in the transmission of the escaping electric force. This manifestation of very exalted intensity and great accumulation also gains instructive expression in another way. It frequently happens that animals out on the open pasture are killed by the electric discharge. Cattle, who are old stagers, cluster themselves together in severe storms, turning their heads inwards and hanging them down, and ranging their backs out like the spokes of a wheel. In this order of arrangement, many of the beasts are apt to be destroyed by one stroke. By reference to his notes of mischief effected by lightning in Natal, the writer finds that, on the 18th of October,

1863, eleven head of cattle belonging to a Kaffir were killed by a lightning discharge near the Noodsberg. On the 13th of December, 1863, five oxen were killed in the same way not far from Maritzburg. On the 21st of October, 1864, fourteen oxen, a cow, and a calf were killed near the Umgeni River. Sheep and other small animals are also sometimes sacrificed in numbers in more open order, while loosely scattered upon the pasture. On the 18th of December, 1862, seventeen calves were struck dead near the Mooi River. On the 27th of September, 1863, twenty-four goats, belonging to a Dutchman named Richter, were struck down, and sixteen of the number killed. On the 18th of October in the same year, five ewes and two lambs were killed near York. The common notion in cases of this kind is, that the animals are destroyed by the lightning passing from one to the other in succession, as the discharge of a Leyden jar passes through the successive links of a chain. The fact, however, is not so. The number of scattered animals destroyed is due *to the breadth of the space* occupied by the discharge. Close inspection of the place where scattered animals have been so killed commonly shows a brown surface, some yards in diameter, of seared grass, burned by the immediate stroke of the lightning. The animals are all but so many points in this broad area of completed contact. The grass is commonly fired by the discharge in the wild country, even when wetted by the rain. One of the chief dangers to which unprotected houses are exposed in the open country is that of the thatch, which is the common covering, being set fire to by the lightning. The Natal mail, which has just arrived in England, states that the house of the clerk of the resident magistrate of the Umzinto district, and also the house of one of the planters in a neighbouring locality, were burned down in this way on the last night of the last year. The Kaffir huts, which are altogether made of thatch and grass, and which are never protected by lightning-conductors of any kind, are consumed very frequently. Occasionally, after a severe thunder-storm, a rude lump of glass, formed from the fusion and vitrifaction of the siliceous cuticle and alkaline ingredients of the reed or thatch, and the blackened ground, are the only traces to show where a Kaffir hut had recently been standing.

Perhaps the next most noteworthy point connected with the lightning in Natal, after these remarkable indications of its inherent energy and power, is the brilliancy and diversity of the colour that it assumes. This is most vividly seen in the broad ribbon of the discharge. The quivering track of light is very commonly of a bright rose tint. But the rosy hue often passes into delicate pink,

or pale blue, or lilac, or it is full orange or purple. Occasionally the discharge is a very pure white, and sometimes of a curious dull leaden hue. There is, indeed, scarcely any gem in the jeweller's repertory that the Natal lightning does not seem capable of copying in the matter of lustre and colour. The beauty of the chromatic display is often enhanced, as the storm drifts away, by the hieroglyphics of coloured light that are traced in the dark masses of the retiring clouds, at each discharge. At one time a large coronal of fire leaps out of the rolling mist, and scatters outwardly radiating lines in all directions. At another time the radiant figure more nearly resembles the aspect which is produced in starred glass; it looks as if a brittle cloud was suddenly cracked and starred with little fissures of fire. Occasionally the fire-track leaps along in grotesque curves, or bent bows with strings, fringes, and offshoots running therefrom in every conceivable direction. Very often, indeed, the lines pass horizontally to and fro, shooting backwards and forwards like the weaver's shuttle, immediately above the flat tops of remote table-mountains, that in a clear day would be visible on the distant horizon, but in the darkness of the storm, or of the evening, only have their presence indicated by these "lightning shuttles" at work in the woof of their cloud table-cloth. Occasionally the perpendicular walls are battlemented with electric fire. There is a very beautiful and characteristic table-mountain of this class, visible, at about twelve miles distance, from the city of Maritzburg, which lies in the line of the retreating storms, and which is constantly the scene of these natural and most beautiful pyrotechnic displays.

The South African table mountains are the frequent cause of very magnificent stretches of bold and wild scenery, and legitimately find a passing notice in this place, on account of the sympathy that seems to exist between their upreared blocks and "cloud table-cloths" and the powers that manufacture and mould the lightning. The accompanying representation (see Plate) is introduced because it gives a very exact and truthful notion of the general character and form of these mountains, and of the grandeur of the scenery that surrounds them. The mountain of this plate is not that which is seen from Maritzburg; but it is the next mountain in the series. The view is one that is contemplated from the shoulder of the Maritzburg table-mountain, and is indeed the engraver's reproduction of a photograph made from that spot by the writer. It comprises the valley of the Umgeni, which river is seen like a silver thread winding for miles, hundreds of feet below, as it

comes down from a spot where it leaps a mighty precipice of columnar basalt in a cascade twice the height of Niagara.

The foliage clothing the sides and bottoms of the valley is composed principally of flat-topped thorny mimosas, and the small circular object on the hill side to the right is a native village, or kraal; a circular cluster of the straw, beehive-like huts which are constructed as dwelling-places by the Kaffirs. The table-mountain, like all the rest of its class, is a grand, ribbed pedestal of granite, or gneiss, many hundred feet high, bearing aloft upon its summit a thick, horizontal block or slab of old sandstone, with bare and precipitous sides. The ribs and buttresses of the base are all masked in vegetation, and verdant with grass and shrubs. But the top of the table is naked rock, scored by the horizontal shelf-like edges of the successive layers of the sandstone, and shining forth above the green base in the brightest and boldest relief when it is illuminated by the low glancing rays of the evening sun. The valley in the engraving inadequately represents the brilliant sinuous silver line of the river, but otherwise renders very well indeed the character of the beautiful hollows that lie between these fine old isolated flat-topped mountains of Southern Africa. These characteristic masses are of common occurrence in all directions, and seem really to be but so many remnants of the old broadly-spread pavement which was once evenly continuous with the great central table-land of the continent. In ages long gone by, the sanded floor of a yet older sea seems to have been lifted to form the dry continent of Africa. At some subsequent time the reared pavement of this continent was shattered and broken into several fragments, by yawning chasms, opened by the earthquake. At the present day some of these several fragments still stand, mountain-monuments of the past convulsion, reared upon their enduring pedestals. The chasms, however, have been widened into broad rolling basins, and grooves moulded in granite and trap. What has become then of the sandstone slabs that once overlaid these intervals in continuation of the tops of the table mountains? No one can say. All trace of the old ruin, saving these table mountain-monuments and the intervening chaos of bared granite and trap, has entirely disappeared. The thoughtful observer who rides through the valleys, and measures their vast spaces simultaneously with his eye and by the time occupied in traversing them, can, however, scarcely escape from the conviction that the lost slabs of the old pavement have been all sucked down into the sea of molten rock that welled up through the chasms of the convulsion, to be there fused and "metamor-

phosed" into the crystalline, and trappæan, and slaty substances that now form the floors and sides of the "unpavemented" hollows and intervals.

The brilliant colours of the Natal lightning bring forcibly to the mind of the thoughtful observer the way in which modern science explains the production of "electric fire." The electricians hold that the light of the electric discharge is entirely due to the absorption of minute metallic particles present in the vapours of the air, and that the differences of colour depend on the diversity of the substances that are thus rendered incandescent by the transmission of the high electric tenison. The resemblance of these Natal lightnings to the brilliant lights developed by the combustion of metals, immediately strikes the eye. The radiant tracks that shoot out in the clouds over the mountain tops most curiously reproduce in large the effect that is witnessed in miniature, when a strong electric spark is taken upon a ball coated with gold-leaf or copper-leaf. Singular instances occasionally occur in Natal, as elsewhere, in illustration of the idiosyncrasy of the lightning to make free with the metallic principles which it needs for the sustenance of its flames. The writer met with one case in which some picture frames were nearly stripped of their gilding by a lightning-stroke, that shattered the house containing them, without further mischief being done to the pictures. Instances of this character immediately recall to the memory the anecdote recorded by M. de la Rive, of the lady's arm which was robbed of its gold bracelet by a flash of lightning, as the lady closed a casement, without any serious mischief being inflicted upon the arm itself.

There is yet one other most beautiful form in which electric light is commonly seen late in the Natal evenings. As the thunder-storm drifts away, the edges of the retreating clouds are illuminated by the play of the electric discharges which are in process of running to and fro where the immediate track of the discharge is veiled from the eye by the intervening masses of thick vapour. The effect of this "distant play" of the lightning is inconceivably grand. No effect of "sheet lightning" encountered in England can be even compared with it. The dark broken edges of the cloud are brought out in the most varied and fantastic forms, and in the most intense clearness, by a vista of coloured glow that seems, for the instant, to open out glimpses of a deep infinity beyond. At times, these Aurora-like glows may be seen flashing out from beneath the broad cloud-canopy that covers the higher heavens, in all parts of the horizon in rapid succession, as if "repeating signals" to each other,

and this splendid display is apt occasionally to continue for a long period of time, possibly stretching to hours. The writer has noted these "sheet-lightning signals" being thrown out from six distinct points of the horizon at once, and he has counted fifty-six flashes in the minute. The effect is no doubt produced by reflection from cloud-vapour of the light emanating from the small discharges which are constantly at work equalizing the disturbed electric tensions of different portions of the storm canopy, and which constitute the "coronal" and "radiant" and "starred glass" fire-tracings already alluded to, when the actual tracks of the discharges themselves are in sight.

It will be readily understood, from the explanation which has been now given of the "manufacture of the thunder-storm" in this district of South-Eastern Africa, that the effect is most frequently and most constantly produced, in the hottest period of the year, when the great operative who works the process—the sun—is in most energetic activity. Forty-seven thunder-storms occur at Maritzburg, on the average, in the eight months that lie between September and April. But only four occur in the four months that lie between May and August. At least eight storms occur in each of the midsummer months of December and January. In the winter months, the same series of aerial movements go on, but with far inferior energy. The clouds get piled up round and over the higher hills in the late afternoon, and silent lightnings may be seen playing among them. But the disturbance only on very rare occasions gathers head into the rapid and copious condensation which is essential to the development of the actual tempest. This has a very remarkable and important effect upon the climate of Natal. The winter is a period of genial, almost uninterrupted sunshine, and the temperature is kept agreeably high through that season. The mean temperature of the six winter months at Maritzburg is 60° of Fahrenheit's scale, while the summer is a period of no less frequent cloud and abundant moisture and evaporation. In consequence of the constant drawing of the afternoon cloud-screens, and the constant sprinkling of the heated land, and the cooling evaporation which naturally follows from the sprinkling, the mean temperature of the six summer months at Maritzburg is only 69°.

The more important benefit worked by these thunder-storms is, however, the energetic vegetation which is called forth in consequence of this most auspicious combination of punctual periodic watering with the nearly tropical summer sunshine. The land is like a well-kept conservatory, where, while a steady bottom-heat is

maintained, the rose of the watering-pot is turned by the gardener's careful hand now on this side, and now on that, so that the soil is always drenched with the life-carrying stream. On this account, the entire country is literally clothed with verdure, from the sands of the sea to the tops of the mountains, during the greater part of the year. There is, however, so much of deep interest to be told of the twin-sister of the lightning and thunder—namely, the rain-fall; the direct aqueous condensation and deposit which accompanies, and indeed causes, the electrical manifestation—in Natal, that the subject cannot be touched upon at the end of a paper. Neither can the curious illustrations of the mechanical effect of the lightning-discharge, and the protective powers of the lightning-rod, which this "favourite haunt and home" of the meteor affords, be now spoken of as they might have been had space and opportunity allowed. These are both subjects that must wait for another occasion.

ASTRONOMICAL NOTES FOR MAY.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

VENUS and Saturn are this month, also, the only planets suitable for evening observation.

VENUS is at her greatest elongation on the morning of May 7th, at 11h. 32m., and is afterwards horned. As she is still approaching the Earth, she will constantly increase in apparent brilliancy. On the first day she sets at 11h. 47m.; but as her path in the heavens begins after the 6th to carry her in a southerly direction, she will shortly afterwards set rather earlier, the time on the last day of the month being 11h. 26m. Early in the month she will pass from the constellation Taurus into Gemini, and continue there until June. About the 28th of May, she will pass between 3° and 4° to the south of Pollux. In the last evenings of the month, therefore, Castor and Pollux will form a very beautiful group with her, and will set off still more conspicuously her surpassing brilliancy.

SATURN rises on the first day at 9h. 6m. in the evening, and on the last day at 6h. 56m. During the first half of the month he will be very near the close double star ν Scorpii; towards the end of it he will approach a position nearly due north by about 2° of ω^1 and ω^2 Scorpii, two stars each of the 4½ magnitude, situated within less

than half a degree of each other. As we mentioned last month, the occasion is in other respects very favourable for observing Saturn's rings; but it is unfortunate that the planet is low in the heavens, its meridian altitude being, in fact, only about 20°.

OCCULTATIONS OF STARS BY THE MOON.—Two only of these phenomena that are of any importance will occur this month in the evening. They are:—

DAY.	NAME OF STAR.	M.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
May 4	l^{2} Virginis	5	9 7	56	10 21	236
„ 27	18 Leonis	6	10 31	99	11 25	304

It may here be desirable again to call attention to the fact which was mentioned in the April number of the STUDENT, under the head "Astronomical Items," that Mr. Marth, through Mr. Newall, brought under the notice of the Royal Astronomical Society at its meeting in March, the probability, if the weather be favourable, of the occultation of the bright star Aldebaran on the *afternoon* of May 22 being observable. That phenomenon is not noticed in the "Nautical Almanac," from its occurring only about twelve hours after the New Moon. But as Aldebaran is a star well suited for daylight observation, and will be about 8° distant from the Sun, there appears sufficient reason for thinking it possible to make the observation with a good telescope, if the sky be free from both cloud and haze. At Greenwich the times of disappearance and reappearance will be 6h. 26m. and 7h. 13m. respectively; the angles at the Moon's centre made at those times by lines drawn to her north point and to the star, 55° and 295°. The reappearance will take place near the middle of the illuminated crescent, the breadth of which will there be about ten seconds of arc.

THE MOON.—We give, as last month, a table of the phases of the Moon, and the more remarkable objects which will be under or near the terminator on some of the evenings.

May 1. Mare Imbrium, Copernicus, Bullialdus.
„ 3. Kepler, Mare Humorum, Gassendi.
„ 4. Aristarchus, Schickhard.
„ 5. Galileo, Hevel, Grimaldi, Riccioli.
„ 6. Full Moon at 6h. 37m. P.M.
„ 7, 8. Mare Crisium, Langrenius.

May 9. Mare Fœcunditatis.
 „ 10. Mare Tranquillitatis.
 „ 14. Last Quarter at 5h. 15m. P.M.
 „ 22. New Moon at 6h. 36m. A.M.
 „ 24. Mare Crisium.
 „ 25. Posidonius, Mare Fœcunditatis, Theophilus.
 „ 26. Mare Serenitatis, Linné, Plinius.
 „ 27. Aristippus, Autolycus, Hipparchus, etc., coming into view.
 „ 28. First Quarter at 11h. 42m. P.M. Archimedes, Ptolemæus, etc.
 „ 29. Plato, Eratosthenes, Mare Nubium.
 „ 30. Mare Imbrium, Copernicus.
 „ 31. Reinhold, Bullialdus.

ORBIT OF 70 OPHIUCHI.—It is well known how interesting has been the whole subject of double stars ever since Sir William Herschel, about the beginning of the present century, published the results of his observations of a considerable number of them, containing the remarkable discovery of the existence of physically-connected or binary stars. He was first led to the systematic observation of the mutual distances and angles of position of double stars, by the hope of being enabled to detect thereby the existence and amount of their annual parallax and actual distance in the way in which the matter has since, in the hands first of Bessel and afterwards of others, been brought in several instances to a successful issue. But the great number of stars which were found to be in extremely close proximity, was itself sufficient to suggest some connection more intimate than mere casual or optical juxtaposition; and after carrying on his measures for some time, Herschel found his attention carried off from the original subject of inquiry by phenomena of a character then unexpected, but with which we are now familiar. These consist in changes of position which indicate the orbital motion of one star of the double star round the other, that is, of one *sun* round another *sun;* and the orbits of several of them have more recently been determined with a greater or less degree of accuracy, showing that the Newtonian law of gravitation obtains in these systems as well as in our own. A very elaborate investigation of that of the double star 70 or *p* Ophiuchi (the components of which are of the 4½ and 7th magnitudes respectively) has just been published in the "Astronomische Nachrichten," by Dr. Schur. It is the more interesting because the annual parallax, and therefore distance of the star, are approximately known. Its right ascension is 17h. 59m.; north polar distance, 87° 28′. Its duplicity

was discovered by Herschel in the year 1779. Struve, whose labours, first at Dorpat and afterwards at Pulkowa, placed him at the head of this department of astronomy, and who distributed the double stars into classes according to the proximity of the components, commencing with the nearest as the first class, placed this in the fourth class, that is, that of stars whose mutual distance is between 4″ and 8″, it being, in fact, in this case about 5″.

Sir William Herschel observed this remarkable double star from 1779 until 1804; after that time it was not observed till Struve commenced to devote attention to it in the year 1819. The companion star had in the mean time, in its revolution round its primary, passed (in 1808) its perihelion. Since that time it has been observed a great number of times by Sir John Herschel, South, Dawes, Bessel, Otto Struve, Mädler, Dembowski, and others. Nevertheless, the determination of its orbit has given calculators much trouble and perplexity. Doubts were even entertained of its obedience to the Newtonian law, and Mädler called the determination of the orbit an *experimentum crucis*.

The first determination was made by Professor Encke. He followed a method of his own, which in principle was similar to that of M. Savary (the first who determined, in the case of ξ Ursæ Majoris, the orbit of a binary star), but was in some respects an improvement upon it. The resulting period of revolution was about seventy-four years. The observations made use of extended to the year 1823. Whilst those observations were well represented by the orbit thus determined, later ones by Struve at Dorpat and by Bessel at Königsberg appeared to be quite irreconcilable with it, the former in the distances, the latter in the position-angles. An attempt to obtain a better orbit by uniting these with the early ones of W. Herschel, led to discordances equally inexplicable with the observations of J. Herschel and South. The principal cause of these discordances appears to be the attributing too much weight to the early observations, when the methods were much less perfect.

Sir John Herschel and Mädler afterwards made a determination of the orbit, each finding the period to be a little more than eighty years. The former employed a graphical method, by which the distances only were used to determine the dimensions of the orbit, and all the other elements were deduced from the position-angles. As might be expected, the latter were well represented; but the agreement of the distances was not so good, and the discordances seemed to show that almost all the distances measured by the Dorpat refractor were too small—indicating that the discordances were probably due to the method of observation. Mädler, in the

endeavour to reconcile all the observations, made three determinations of the orbit, but at last concluded that either (1) the motion in this binary system does not follow the Newtonian law, or (2) the centres of the images of the stars as seen by us are not the centres of gravity of their masses. He considered the latter the more probable hypothesis, and adduced the analogous cases of Sirius and Procyon, in both of which Bessel had conjectured the existence of a disturbing body.

Mr. E. B. Powell also made a determination of the orbit, with a period of ninety-eight years: but the distances observed afterwards showed a considerable deviation from those obtained from his orbit. Yvon Villarceau also calculated one according to a very elegant method of his own, making the period ninety-three years; but although it well represented the observations after 1823, comparison with those anterior to that date showed the necessity of an alteration in it.

Captain Jacob executed two determinations, the second of which is interesting from the attempt made in it to explain the anomalies in the motion of 70 Ophiuchi by assuming, in accordance with the suggestion of Mädler, the existence of a third body in its system—an opaque and invisible body in the neighbourhood of the fainter of the two stars disturbing the motions of both. However ingenious is this attempt (and a similar cause is now generally admitted to account for the irregularities in the proper motion of Sirius), yet Dr. Schur states that it appears to him that the anomalies may be quite as easily removed by a small change in the elements; and, moreover, they are too small to draw from them conclusions of any certainty with regard to the existence, much less the elements, of a third disturbing body.

In the year 1855, Professor Klinkerfues published a new determination of the orbit, which well represented all the observations up to 1852 (which were employed in the investigation) on the supposition of an ellipse. The only remarkable discordance was in the position-angles about 1832, which seemed to indicate the necessity of a diminution in his periodic time, which amounted to nearly ninety-six years. Although the earlier doubts about the possibility of thus reconciling with sufficient accuracy all the observations on this hypothesis were thus satisfactorily removed, yet Dr. Schur, in the paper before us, says that he considered it desirable again to repeat the process, both on account of the discordance referred to, and because, since the year 1852, a great number of good observations had been made by Dembowski, Dawes, Otto Struve, Mädler, and others: moreover, the passage of the companion star through its aphelion in 1856, gave hopes of thereby determining the dimen-

sions of the orbit with greater certainty. He has, therefore, furnished another determination, from an elaborate discussion of all the materials, making use of the method of Sir John Herschel with some modifications. The orbit he finally determined is in very close agreement with all the observations up to the present time, the only discordance of any amount being shown by those made between 1823 and 1827, some constant or similar error in which was probably the principal cause of the difficulty found by earlier calculators in reconciling all the observations, when there were, besides those, a much smaller number available than at present for the construction of an orbit. Of the elements definitively adopted by Schur, the time of perihelion passage is 1808·79; semi-major axis 4″·9063; eccentricity 0·4915; periodic time 94·37 years.

It was now possible to determine the actual mass of this double star, in terms of that of the Sun. For Krüger had, from the observations with the Bonn heliometer, in the years 1858—1862, obtained a measurement of its annual parallax, finding it to be 0″·162, with a probable error of 0″·0071, which gave a distance of the star from the solar system amounting to 1,273,000 times that of the Earth from the Sun; that is, one which light would occupy 20·1 years in traversing. Hence Schur finds that the mean distance of the two stars from each other is about 30·3 radii of the Earth's orbit, and that their mass is about 3·12 times that of the central body of our system.

Brorsen's Comet.—The return of this comet to perihelion leads us to devote a few words to its previous history. It was discovered at Kiel by Brorsen, then a student there, on February 26, 1846, at eight o'clock in the evening, near η Piscium, and telescopic. Two days afterwards it was in consequence observed by Petersen at Altona, and by Rümker at Hamburg. At first it was suspected that it might be the same with one which had been detected by De Vico on February 20; but comparison of the place observed by the latter with one deduced from elements of Brorsen's comet, which had been calculated by Petersen, showed that they were really different comets. And, accordingly, Brorsen himself found the other also on March 8, and it was afterwards observed by other persons. Later in the month, elliptic elements of Brorsen's comet were calculated by Dr. Brünnow and by Mr. Hind, and the period shown to be about five and a half years. It had passed its perihelion on February 25, or one day before its discovery. By April 22 it had become, according to Encke, "such an extremely faint and diffused nebulous patch, that very faint stars near it prevented its being seen."

The next perihelion passage occurred in September, 1851; but at that return the comet was not seen, owing to its unfavourable position with respect to the Sun.

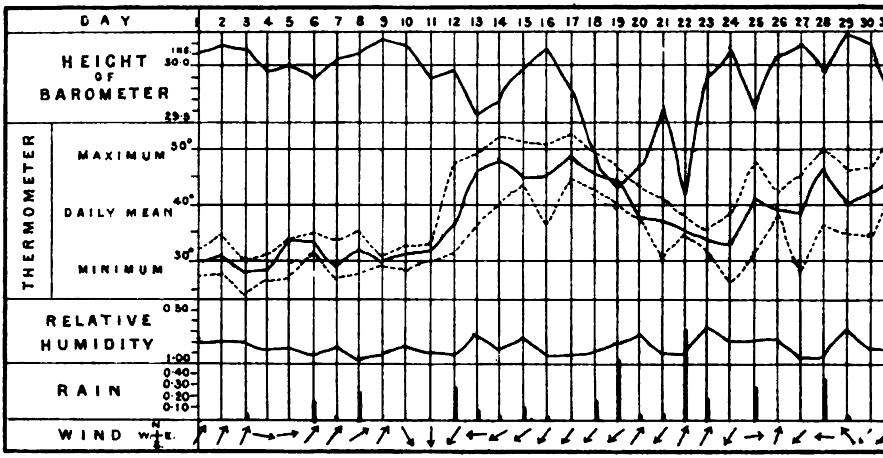
At the next return, in 1857, it was first detected by Dr. Bruhns on March 18. Pope showed that the comet thus discovered was identical with Brorsen's of 1846, and computed elements of the orbit. This comet passed its perihelion on March 29. In appearance it resembled a round nebula of about 2′ in diameter, and was a little condensed towards the centre, but very faint. It was, however, brighter than when observed in 1846, and about the middle of April the centre was much condensed, though there was no defined nucleus; it never showed any trace of a tail. Prof. d'Arrest showed that the comet had been thrown into its present orbit in 1842, in consequence of a very near approach to the planet Jupiter in the spring of that year; previous to which its perihelion distance was considerably greater. Its history, therefore, presents a remarkable analogy to that of Lexell's comet, in which, however, the alteration of path was much greater.

At the next return to perihelion, in the autumn of 1862, Brorsen's comet escaped observation, as in the year 1851. As the forthcoming perihelion passage at the time we write, will be past when these pages meet the reader's eye since it occurs towards the end of April, it is possible that he will then know more of the comet than we can now acquaint him with; but the foregoing particulars concerning its previous history may not be uninteresting.

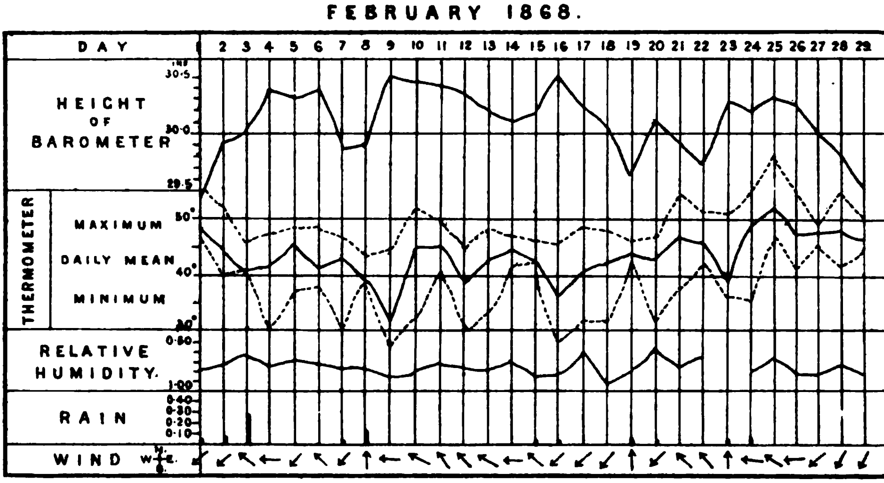
ADDENDUM.—Since the above was written, an ephemeris of the comet has been published by Prof. Bruhns of Leipzig. He fixes its perihelion passage for April 18, about midnight. But the comet will continue to approach the Earth until nearly the end of May. It is also rapidly attaining a greater northern declination. The place will be on May 1, R.A. 4h. 53m., N.P.D. 53° 56′; on May 6, R.A. 5h. 28m., N.P.D. 49° 27′; on May 11, R.A. 6h. 7m., N.P.D. 45° 35′; and on May 16, R.A. 6h. 52m., N.P.D. 42° 36′. Its course in the heavens will carry it during that time from the constellation Auriga (being very near β Aurigæ on May 9), into that of Lynx, which consists almost entirely of small stars. Even at the beginning of the month, it will pass the meridian between two and three o'clock in the afternoon, and will continue above the horizon until midnight: during the latter part of the month it will not set at all. The Full Moon occurring on the 6th, will probably make the observation for some days before and after that date extremely difficult, if not impossible.

DIAGRAMS, REPRESENTING THE METEOROLOGICAL VARIATIONS AT THE KEW OBSERVATORY.

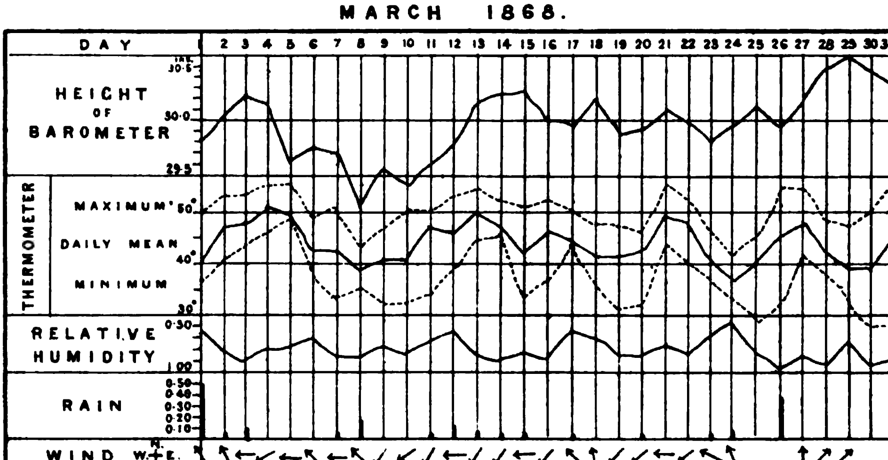
JANUARY 1868.

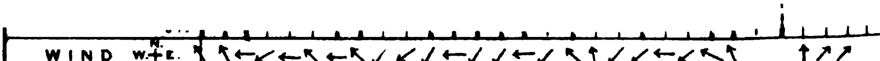


FEBRUARY 1868.



MARCH 1868.

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RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LAT. 51° 28′ 6″. LONG. 0° 18′ 47″ W.

BY. G. M. WHIPPLE.

(*With three Plates.*)

IN the discussion of the present series of observations, we retain the form adopted in the last, and for the explanation of which we must refer the reader to the February number of the STUDENT.

JANUARY, 1868.

ATMOSPHERIC PRESSURE.—The mean barometric reading for the 1st inst. being 30·156, there was a steady downward movement to 29·880; on the 6th a gradual rise ensued, till the 9th, 30·235, after which the pressure steadily diminished up to noon on the 12th. A more rapid fall then commenced, which lasted till 8.30 A.M., on the 13th, the mean for that day being 29·539. The readings increased slowly to 30·140 on the 16th. At midnight on the 17th a fall began, lasting throughout the 18th, arriving at its lowest point at midnight on the 19th, the mean reading on the 19th being 29·053. The barometer rose to 29·606 on the 21st, falling again to 29·094 on the next day. At 4 P.M., on the 22nd, a continuous rise set in, which culminated 10 A.M., 24th. Afterwards, pressure diminished till midnight, the mean 24th was 30·135. After the 25th, we had increasing pressures to the 29th, 30·314, then diminishing to 29,872 on the 31st.

Mean height for the month = 29·890.

TEMPERATURE OF THE AIR.—The earlier part of the month was very cold, the temperature on the 1st being 30·0 and 28·2, 28·5 on the 3rd and 4th. The 5th and 6th were a few degrees warmer, but the thermometer was lower on the five succeeding days. After the 11th it rose rapidly to 48·5; the 14th, 15th, and 16th were a trifle colder, but the 17th was the warmest day during the month, the mean temperature being 49·0. At 8.45 A.M., on that day, a sudden fall of 5° was recorded, accompanied by a heavy shower of rain; a similar fall of 3°, also accompanied by rain, occurred just after midnight on the 18th. The readings then steadily diminished to 33·4 on the 24th, with the exception of an abrupt rise of 3° at 4.15 A.M., on the 22nd.

The temperature gradually rose to 8.20 P.M. on the 28th, after which a fall occurred, the mean on the 31st being 43·8°.

The highest maxima were—17th, 52·6°; 14th, 52·4°; and 31st, 52·3°. The lowest—3rd, 29·8°; 4th, 30·3°; and 9th, 30·4°.

The highest minima recorded were on the 15th and 17th, being 43·1° and 45·1°; and the lowest 23·8°, on the 3rd.

The extent of daily range was greatest on the 27th, 16·5°; 16·1° was registered on the 25th, and 15·8° on the 12th.

The smallest range was 1·3° on the 9th, on the 22nd it was 1·4°.

The mean temperature of the month was 37·8°.

The Relative Humidity of the air varied but slightly. The days on which the amount of vapour present in the atmosphere was least (complete saturation being 1·0), were the 23rd, ·68, and 29th, ·69; the days of greatest moisture were 8th, ·99, and 27th, ·96.

The monthly mean being 0·86.

Rainfall.—The amount of rain measured was as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
3......	0·012* inch.	14......	0·047 inch.	21......	0·003 inch.
6......	0·113* „	15......	0·075 „	22......	0·800 „
7......	0·010* „	16......	0·005 „	23......	0·147 „
8......	0·248* „	18......	0·142 „	25......	0·300 „
12......	0·283 „	19......	0·584 „	28......	0·390 „
13......	0·090 „	20......	0·035 „	29......	0·040 „

Those quantities marked * were melted snow.

Total fall during the month = 3·324 inches.

Wind.—The direction of the prevailing winds is shown by the small arrows occupying the lower part of the diagram.

It was:—

North—22nd, 23rd, and 26th.
North-East—1st, 2nd, 3rd, 6th, 7th, 8th, 9th, and 20th.
East—4th and 5th.
South-East—10th.
South—11th.
South-West—12th, 16th, 17th, 18th, 21st, and 24th.
West—13th, 14th, 19th, 25th, 27th, 28th, 30th, and 31st.
North-West—29th.

The velocity of the wind was generally moderate up till midnight on the 12th, but during the next two days it blew at a rate varying from twenty to thirty miles per hour. The 16th was calmer in the early morning, but after noon it blew more briskly, and continued rough till midnight on the 19th, the greatest velocity recorded being forty miles at 1 P.M. on the 18th. During the 20th, the direction veered from W. to S., to E., N., and W. again in the twenty-four hours. At 4.18 A.M. on the 22nd, a change of direction from N.E. to W. was recorded. The wind was very rough during the night of the 24th, its velocity being thirty-seven miles at midnight. At 2 A.M. of the 25th, it moderated to 11 miles, veering at the same time from S. to W.

FEBRUARY.

ATMOSPHERIC PRESSURE.—The barometer was falling at the end of the last month, and the mean for the 1st was 29·415. The fall continued till noon on the 2nd, after which it rose steadily to 30·374 on the 4th. The reading on the 7th was 29·894. At 3.30 A.M. on the 8th it ceased falling, and rising rapidly, gave 30·553 on the 9th.

The pressure steadily diminished to 30·121 on the 14th, increasing afterwards to 30·542 on the 16th. The mean for the 19th was 29·638; the next day gave 30·119, but a fall followed. At 10.30 P.M. on the 22nd, a sudden small rise of ·05 inch of the barometer was recorded, and through the 23rd it continued rising, giving a mean of 30·242. After reaching 30·344 on the 25th, it continuously fell, arriving at the minimum and turning at 7.15 P.M. on the 29th, that day's mean being 29·490.

Mean height for the month = 30·123 inches.

TEMPERATURE OF THE AIR.—This was 48·2 on the 1st, and a steady diminution followed to 41·2 on the 4th, interrupted only by a rise from 10 P.M. to midnight on the 2nd. From 45·1 on the 5th, the thermometer went down to 31·7 on the 9th, that being the coldest day in the month. The 10th was milder, 44·9 being the mean. Falling through the night of the 11th, gave 39·6 the next day, again rising to 45·1 on the 14th. On the 15th the thermograph recorded a rapid fall of 5° at 2 P.M., the thermometer returning to its original position soon after.

The succeeding days were a little warmer. On the 22nd we find several strange fluctuations indicated. At 11 A.M. the thermometer fell 5° rising again after; this was repeated soon after noon, and a similar fall of 3° occurred at 10.30 P.M.

The 25th was the warmest day of the month, being 52·1. The temperature was a little lower after, being 46·3 on the 29th.

The days on which the highest maxima were recorded were 25th, 60·9, and 1st, 55·9, the lowest being 43·4 on the 8th.

Low minima were registered, 27·5 on the 9th, and 28·9 on 16th. The high minima were 25th, 47·8; 1st, 47·5.

The greatest daily range was 19·5, on the 10th. The least 2·3, on the 3rd.

The mean temperature for the month, 43·5.

Relative Humidity.—The days of comparative dryness were 17th and 22nd, the degrees of humidity being then ·63, and ·65.

The 18th was the day on which most aqueous vapour was present, being ·96.

The mean for the month, 0·75.

Rainfall.—This was very small in February, the recorded quantities being:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1......	0·023 inch.	8......	0·108 inch.	20......	0·020 inch.
2......	0·031 „	15......	0·020 „	21......	0·037 „
3......	0·273 „	16......	0·021 „	23......	0·014 „
7......	0·004 „	19......	0·030 „	24......	0·015 „

Giving a total fall of 0·596 inch for the month.

Wind.—The general direction of the wind was:—

North—8th, 19th, and 23rd.
South—19th, 28th, and 29th.
South-West—7th, 18th, and 20th.
West—1st, 2nd, 4th, 5th, 9th, 14th, 16th, 17th, 24th, 26th, and 27th.
North-West—3rd, 6th, 10th, 11th, 12th, 13th, 15th, 21st, 22nd, and 25th.

The velocity of the wind was very brisk on the 1st, being 49 miles per hour at 1 P.M.; it diminished gradually, nearly ceasing at 3 P.M. on the 2nd.

At the same time the direction changed from W. to S. At 10 P.M. it veered back to W., the velocity increasing to 30 miles, but went down again at 3.30 A.M. on the 3rd.

The night of the 6th was nearly calm, and the direction changed from W. to S.E.; 3.30 A.M. on the 8th recorded a veering from S.W. to N.W.

About noon on the 19th the wind, which had been blowing at 20 miles, dropped to 5, the direction changing from S. to N. Aftei a short time the velocity went up to 20, and on the 20th, 5 A.M., the direction went back to S.W. During the next night the velocity was 25 miles, calming down at 5 A.M. on 21st. The rate was more than 30 miles per hour on the 29th, up to 7 P.M., when it diminished to 10, direction changing from S. to N.W.

MARCH.

ATMOSPHERIC PRESSURE.—From 29·851 on the 1st, the barometer rose to 30·220 on the 3rd. At noon on the 4th it began to fall steadily, reducing the next day's mean to 29·640.

After noon on the 7th, the pressure rapidly diminished, until the 8th, 5.15 A.M., when an instantaneous rise of 0·1 inch occurred, after this the increase of pressure was continuous till next day. The mean for the 8th, was the lowest during the month, 29·143.

Rising readings continued up to 30·224 on the 15th; the 16th, and the 17th were a little lower, but the 18th was again 30·210.

The variation was small for some days succeeding. At 11.30 P.M. on the 22nd a sudden rise of about 0·07 inch was recorded.

From 29·956, on the 26th, the barometer gradually went up to 30·578, on the 29th, this being the highest daily mean during the month, a fall followed to 30·382 on the 31st.

The mean height of the barometer for the month was 29·982.

TEMPERATURE OF THE AIR.—This was 39·9 on the 1st, and was followed by increasing temperatures up to 50·8° on the 4th, a noticeable feature being a rise of 2° recorded at 3 P.M. on the 2nd.

At 3 P.M. on the 6th, the thermometer fell 4°, rising gradually after to its former position. The 8th was characterized by two sudden falls, the one of 6°, recorded at 5.20, and followed by steady decrease of temperature, the other of 4°, at noon, succeeded by a rise, the mean for the day being 39·0°. After the 10th, the days were somewhat warmer, reaching 50·4° on the 13th, this was the highest daily mean for the month, the temperature on the 21st being 50·1°. The thermometer was unusually stationary all through the 22nd up to 11.30 P.M., when it suddenly dropped 6°. On the 23rd it was very fluctuating, and the next day was the lowest mean in the month 37·3°. The readings increased to 48·1° on the 27th, coming down to 40·0° on the 29th and 30th, rose again to 45·4° on the 31st.

The highest maximum temperature registered during the month was on the 31st, 57·7°; the lowest, 42·3°, on the 24th.

The highest minimum temperature recorded was 48·5°, on the 5th, the lowest being that for the 30th, 28·5°.

The largest daily range was that for the 31st, 29·0°; the smallest, 5·9°, on the 17th, and the mean for the month 14·0°.

The mean temperature of the same period was 44·3°.

RELATIVE HUMIDITY.—This month was generally drier than the preceding two. The degree of moisture present in the air being 0·52 on the 24th, therefore the driest day in the month. The proportion was 0·61 on the 1st and 17th.

The day of greatest humidity was the 26th, 0·98.

The mean for the month = 0·79 inches.

RAINFALL.—There were no large amounts of rain recorded during March, the quantities measured being as follows:—

DAY.	AMOUNT.	DAY.	AMOUNT.	DAY.	AMOUNT.
1......	0·510 inch.	11......	0·017 inch.	20......	0·015 inch.
2......	0·013 „	12......	0·083 „	21......	0·003 „
3......	0·050 „	13......	0·060 „	23......	0·015 „
6......	0·008 „	14......	0·020 „	24......	0·025 „
7......	0·010 „	15......	0·025 „	26......	0·406 „
8......	0·180 „	17......	0·025 „		

Giving a total fall in the month of 1·464 inches.

WIND.—The general direction was:—

North—18th and 27th.
North-East—28th and 29th.
South—10th, 11th, and 30th.
South-West—4th, 9th, 13th, 14th, 16th, 19th, and 31st.
West—3rd, 5th, 7th, 12th, 15th, 20th, 21st, and 22nd.
North-West—1st, 2nd, 6th, 8th, 17th, 23rd, and 24th.

The 8th was noticeable for a change of direction and force, which occurred at 5.20 A.M., the wind veering from S.W. to N.W. The wind was very gentle on the 15th, being nearly calm from 5.30 to 8 P.M. At 8 A.M. on the 16th the velocity increased, attaining the rate of from twenty-five to thirty miles per hour, up to 5 A.M. on the 17th, then it changed from S.W. to N.W., and went down. The night of the 18th was calm.

At 11.30 P.M. on the 22nd the direction changed from S.W. to N., and the velocity diminished considerably.

At 1.20 and 3 P.M. on the 23rd, strong northerly gusts were recorded, the general direction at the time being W. During the 25th the wind gradually veered from N. by W. to S., returning again to N.W. the next day.

ON THE NEW THEORIES IN CHEMISTRY.

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No. III.

WHEN compounds are brought into contact, an interchange of their constituents frequently takes place, but contact is necessary to effect this. Heat produces change in the state of substances; when this change continues only as long as the body remains under the influence of heat, its effect is called physical, but when it causes a permanent alteration in the constitution of the substance, the effect is chemical.* For example, iron when heated increases in bulk and acquires other properties different from what it had when cold; it can combine with chlorine, for example, but when it is allowed to cool it returns to its original dimensions, and assumes its original inertness; but when oxalic acid is heated it breaks up into three other compounds, and if these be collected and examined, by passing them through chloride of calcium and caustic soda, and collecting the residual gas, the chloride of calcium will retain water, the soda carbonic acid, and the vessel in which the residue is collected will contain carbonic oxide, bodies formed by a new arrangement of the elements which compose oxalic acid—

$$C_2H_2O_4 = H_2O + CO_2 + CO.$$

Heat has permanently altered the original constitution of the oxalic acid, and its effect is called chemical. It must here be understood that oxalic acid is not supposed to contain its elements in the form of water, carbonic acid, and carbonic oxide, but that when the compound oxalic acid is destroyed by heat, its elements, which were before so arranged as to form that acid, under the strong reagent, are separated, and eventually form the three products mentioned.

* Some metals, for example lead, after being heated, do not return to the same size when cool; an instance of this is seen in the buckling of sinks. This is a physical, not a chemical effect.

It is difficult, if not impossible to draw a clear line of demarcation between the chemical and physical effects produced by heat, or to define accurately in what they consist; or to state where the one begins or the other ends. If phosphorus be heated out of contact with air, or in an atmosphere which contains nothing which can react on it so as to form a compound, such as carbonic acid, and if it be kept for some time at a temperature of about 240° C., it will be changed into a body having a different appearance, and, to a certain extent, different chemical properties. It is, before being heated, a waxy-looking mass, which slowly gives off white fumes of phosphoric acid when exposed to the air, and emits light, is extremely energetic in its action, soluble in bisulphide of carbon, and decomposes a solution of sulphate of copper; after the application of heat it becomes a red amorphous powder, it is not oxidised on exposure to air, nor does it emit light, it is insoluble in bisulphide of carbon, and does not precipitate copper from solutions of its salts. Here heat alone has effected a change which cannot be called simply physical; it is, as far as it goes, chemical, nor is it in any way analogous to the action of heat on compounds, which it breaks up or destroys. The change may be called a molecular re-arrangement, but if so, the expression implies something beyond the ordinary meaning of the words; neither is it analogous to the effect which heat produces on the oxide or sulphide of mercury; for in these the change is not of chemical properties, but one, which, till it is better understood, may be called molecular. There are still other differences between these two kinds of phosphorus which cannot be strictly called physical. The heat produced by the combustion of clear phosphorus is greater than that produced by the other, in the proportion of 1 : 1·15. The specific heat of the red variety is 0·17, and that of clear phosphorus 0·1887. But if red phosphorus be heated to a temperature beyond 240° C., it gradually becomes reconverted into common phosphorus, and distils over as such. Heat, therefore, produces more than what are called physical effects in simple bodies, and is one of the most important agents which the chemist has at his command; for the state in which it places bodies, as will be seen afterwards, disposes them, so to speak, either to combine or to break connection, and to intensify or destroy that property which they have of combining under ordinary circumstances. When two compounds are mixed which do not produce a precipitate, it is supposed that the acids and bases which they contain are equally distributed; thus, if chloride of sodium be mixed with nitrate of potassium, there

will be an interchange of the acids and the bases. Nitrate of sodium and chloride of sodium will exist conjointly with nitrate and chloride of potassium, and these changes will take place in the proportion of the equivalency of the two bases; but if chloride of sodium be mixed with nitrate of silver, supposing them to be employed in equivalent proportions, there will be a perfect interchange of acids. Chloride of silver will be thrown down as a white precipitate, and nitrate of sodium will remain in solution—

$$Na\,Cl + Ag\,NO_3 = Ag\,Cl + Na\,NO_3.$$

The insolubility therefore of a compound, if such an one can be formed by the substances employed, determines the decomposition. When chloride of calcium is made to react on carbonate of ammonia, a white precipitate of carbonate of lime is thrown down—

$$2\left\{(N\,H_4)_2\,O\right\}\,3\,CO_2 + 2\,(Ca\,Cl_2) = 4\,(N\,H_4\,Cl) + 2\,(Ca\,CO_3) + CO_2.$$

But if the mixture in the test tube be heated, the carbonate of lime will be gradually dissolved, chloride of calcium being again formed, carbonate of ammonia being driven off by the heat. In the first instance, the decomposition was determined by the insolubility of the compound produced by the interchange of acids; in the second, the action was reversed by heat; and therefore the volatility of a substance which can be produced by a reaction, determines the decomposition. It cannot therefore be said that there is any "elective affinity" on the part of any one of the constituent substances for the other, carbonic acid cannot be said to have a greater affinity for lime than it has for ammonia, because its attraction for either substance depends on the circumstances under which they are brought together.

To return to our first example, when chloride of sodium is mixed with nitrate of silver, chloride of silver is formed, it cannot be asserted that this is because chlorine has an elective affinity for silver; for if an element which is less energetic than chlorine be brought to act on chloride of silver, it will cause its decomposition, simply because its silver salt is less soluble in the solvent which dissolves chloride of silver than is the chloride. Iodine is much less energetic in its action than chlorine, which is able to separate it from one class of its compounds, and to replace it. Chlorine liberates iodine from a solution of iodide of potassium, and forms a chloride of that base; but iodine can expel chlorine from chloride of silver, iodide of silver being formed; for, if to a saturated solution of chloride of silver in ammonia, iodide of potassium be added, iodide of silver will be precipitated. Equal volumes of chlorine and

hydrogen, when placed in diffused daylight or in direct sunlight, unite, in the first instance slowly, in the latter with explosion, forming hydrochloric acid. Bromine, which in its energy stands between chlorine and iodine, as it does also in its density, does not unite with hydrogen under similar circumstances; but if both be passed through a tube, heated to bright redness, a combination is effected, and hydrobromic acid is formed. But iodine and hydrogen cannot be made to unite directly, their union is formed by indirect methods; and yet iodine is able to separate silver from its chloride. In the case of these hydrogen compounds, there are evidently manifested different degrees in affinity between hydrogen, chlorine, bromine, and iodine, as is also seen from the power which chlorine has of ejecting either of the others from their potassium salts (which as regards stability are similar to their hydrogen salts); and yet under other circumstances, iodine and bromine are able to replace chlorine in its combination with silver (for bromine does the same as iodine, only not so completely, its silver salt being more soluble in ammonia than that of iodine). With these instances before us, it is hardly possible to conceive that there is inherent in a substance a power of attraction or affinity, or whatever it may be termed, which leads it to select bodies with which to combine to the exclusion of others, it seems rather that this affinity depends on a particular state or condition of the bodies induced by heat, or by some other agent, which places them in a suitable state for combination. Silicic acid is so weak an acid, that even carbonic acid can separate it from its soluble compounds; whereas, at a high temperature, it can expel sulphuric, one of the strongest acids, as is seen in the manufacture of glass and other stable silicates, in which sulphate of soda or potassium is used. Again, steam, acted on by red-hot iron, is decomposed, an oxide of iron being formed, and hydrogen set free; but if hydrogen be passed over red-hot ferric-oxide, the hydrogen reduces it, and water is formed. In like manner, oxide of barium (BaO) heated to a certain temperature, about low redness, takes up another atom of oxygen, forming BaO_2, which it loses again at a higher temperature. The affinity of barium for oxygen, therefore, is altered by changes of temperature, and that of iron for the same element manifests itself in a greater or less degree, according to the way in which it is presented to it; the importance of these considerations will, it is hoped, be seen afterwards, when the constitution of complex compounds is described. Whatever may determine combination or decomposition, it is not certainly a property of the body, inherent in it,

such as was implied by the term electric affinity; for if it were so, why should oxygen unite with barium in one proportion at one temperature, and in another at a lower? Elements and compounds are found to behave differently under the action of the galvanic current, some going to the positive, others to the negative pole. When water is decomposed by electrolysis, the hydrogen is given off at the negative and the oxygen at the positive pole; also, when chloride of sodium is subjected to the same decomposing agent, chlorine is found at the positive and sodium at the negative pole; and from these observed properties oxygen and chlorine are called electro-negative, and hydrogen and sodium electro-positive. Other terms for these properties are employed, namely, chlorous and basylous: chlorous, like chlorine or electro-negative; basylous, or acting as a base, like hydrogen or electro-positive. These different states, the chlorous or basylous, also determine the affinity which bodies have for one another. A substance which is electro-negative to others which are electro-positive to it, unites with that which is furthest removed from it in its electric condition. Iron is electro-positive to copper, and if iron be placed in a solution of sulphate of copper, copper is precipitated, and iron takes its place in the solution; for iron, being further removed from SO_4 than copper, which is electro-negative to both, it combines with it to the exclusion of the copper. When substances are said to be electro-negative or electro-positive, it is not meant that they are so absolutely, but relatively to others which have a different condition; and even an element, is believed to be electro-negative to itself, that is, the atoms which form its molecule exist in these two different states.

When chlorine gas is passed into water, in the cold, only half of the chlorine can be precipitated by nitrate of silver; but on filtering off the precipitate, after sufficient nitrate of silver has been added to send down all that can be precipitated, the filtrate will contain the remaining half of the chlorine in a state of combination which cannot be disturbed by nitrate of silver. If, however, it be acted upon by some reducing agent, such for example as zinc and sulphuric acid, the remaining half of the chlorine can be precipitated by nitrate of silver. Here the chlorine passed into the water has decomposed a part of it, and has formed hydrochloric and hypochlorus acid—

$$Cl_2 + H_2O = H\,Cl + H\,Cl\,O.$$

Half of the chlorine has combined with electro-positive hydrogen, and the remaining half with the electro-negative residue of the water, HO. It will be easily seen that HO must be electro-negative, as

the electro-negative oxygen is only half saturated by the basic or electro-positive hydrogen. We therefore conclude that the molecule of free chlorine contained atoms in different states of polarity (an objection has been raised to the use of this word, lest confusion should arise between the idea which it is intended to convey and magnetic polarity); it is true that no one has yet discovered the nature of this property of atoms, but on investigation it may be found to be of a kind analogous to it. When the hypochlorous acid is acted on by the zinc and sulphuric acid, chloride and sulphate of zinc are formed, the hydrogen taking the oxygen of the hypochlorous acid to form water—

$$2\,(H\,Cl\,O) + 2\,(Zn) + H_2\,SO_4 = Zn\,Cl_2 + Zn\,SO_4 + 2\,(H_2O).$$

Here the chlorine has shown electro-negative properties, and has united itself to electro-positive zinc. When chlorine gas therefore is evolved in the free state, its atoms arrange themselves to form molecules, the one atom of the molecule having chlorous or electro-negative, the other basylous or electro-positive properties, and these atoms become chlorous or basylous according to the properties of the bodies with which they are brought into contact at the moment they are set free from the combinations in which they existed. This is an example of the polarity of atoms afforded by the *analysis* of the molecule of chlorine, and we shall see that the *synthesis* of a molecule of oxygen shows that its atoms possess similar properties. Peroxide of hydrogen $H_2\,O_2$, which is made by dissolving peroxide of barium in dilute hydrochloric acid—

$$Ba\,H_2\,O_3 + 2\,(H\,Cl) = H_2\,O_2 + Ba\,Cl_2 + H_2\,O,$$

holds its second atom of oxygen very feebly, so that one would expect it to act as an oxidizing agent in all cases. This, however, is not the case; for, if it be added to a solution of bichromate of potash, it changes the liquid from bright yellow to green by reducing the chromic acid, $Cr\,O_3$, to chromic oxide, $Cr_2\,O_3$. It also reduces the oxides of gold, silver, and platinum, leaving the metals, oxygen being set free, one-half coming from the peroxide of hydrogen, the other from the metallic oxide; and so violent is the action that if it be brought in contact, in a concentrated form, with oxide of silver, the decomposition takes place with considerable violence and rise of temperature. Here the oxygen is held feebly both by the peroxide of hydrogen and by the silver, and being in different electric states the two atoms are able to separate from their combinations and form a molecule of free oxygen. The action really is one of oxidation, for the atom of oxygen, in union with

the silver, oxidizes that of the peroxide, and oxide of oxygen, *i.e.*, free oxygen, is the result. This strange reaction was not for a long time understood until Sir Benjamin Brodie, who was the first to investigate this subject, pointed out, in a paper on "The Condition of Elements at the Moment of Chemical Change,"* that the oxygen in the peroxide of hydrogen and that of the oxide of silver were in two different polar states, the former in the positive, the latter in the negative. He says, "Were it, for example, a hydride of silver which was thus decomposed by the peroxide, and the decomposition of the substances attended with the formation of water, the experiment would have attracted no attention. On the view here given, the formation of the oxygen is as truly a chemical synthesis as the formation of water itself, and may be substituted for it in a chemical change. The oxide of silver is here reduced by the oxygen of the peroxide of hydrogen, just as in other cases it might be by the hydrogen itself, the formation of the silver being the corresponding fact in the decomposition of the oxide of silver to the formation of water in the peroxide of hydrogen, so that the change may be represented thus"—

$$\overset{+}{H_2}\,\overset{-}{O}\,\overset{+}{O}\,\overset{-}{O}\,\overset{+}{Ag}\,\overset{-}{Ag} = H_2O + O_2 + Ag_2.\dagger$$

Another instance of synthesis is found in the formation of a molecule of hydrogen by the action of hydrochloric acid on hydride of copper, which was discovered by Wurtz, who found that when hypophosphorous acid acted on sulphate of copper, a brown hydrate of copper was formed, having the formula Cu_2H_2; and that when this body was acted upon by hydrochloric acid, hydrogen was rapidly set free and subchloride of copper formed. This was very unexpected, because hydrochloric acid is generally believed to have no action on metallic copper.

$$Cu_2H_2 + 2\,(H\,Cl) = Cu_2Cl_3 + H_4.$$

In this case the hydrogen of the cupreous hydride is evidently electro-negative, and that of the hydrochloric acid electro-positive; and as the compound Cu_2H_2 is very unstable, being decomposed at 92° C., the atoms of hydrogen being in different polar states, unite to form free hydrogen.

A further example is afforded by the behaviour of iodine, when an iodide and an iodate are treated with a dilute acid. Iodide of potas-

* Phil. Trans., II., 1850, 759.

† In his paper, Sir B. Brodie uses the old notation thus—

$$\overset{+}{H}\,\overset{-}{O}\,\overset{+}{O}\,\overset{-}{O}\,\overset{+}{Ag\tfrac{1}{2}}\,\overset{-}{Ag\tfrac{1}{2}} = HO + O_2 + Ag.$$

sium, when pure, is not decomposed by hydrochloric acid, which is free from chlorine; nor is pure iodate of potassium decomposed by an acid, but when iodide and iodate are mixed, acetic acid sets iodine free, and the free iodine is built up of the atoms existing in the two different potash salts. This is just the reverse of the action which we before considered in the case of chlorine, with this difference, that when iodine is added to a solution of hydrate of potash, hydriodic acid, $H\,I$, is formed along with iodic, $H\,I\,O_3$, there being no compound of iodine with oxygen similar to hypochlorous acid, iodine having, under similar conditions, a more powerful affinity for oxygen than chlorine has. The molecules of iodine, as those of chlorine did, break up into their atoms, some of which exhibit basylous, while others show chlorous properties. It would occupy too much of our space to cite more of the many examples which might be brought forward to illustrate this point. Those who desire to follow up this very interesting and important subject, are referred to Sir B. Brodie's very able paper. The molecules of the elements, then, are composed of atoms with electro-positive and electro-negative properties, so that chlorine is $Cl\,Cl$, chloride of chlorine, one atom positive, the other negative to it, and the same is the case with the other elements. $H\,H$ is hydride of hydrogen, and the molecule is, so to speak, as regards these properties, in a state of equilibrium. The electro-positive atom, H, cannot exist alone, nor can that which is electro-negative; so that when the atoms are set free from any combination they instantly unite together to form the free element, or with some other body in contact with them, and this is what is meant by the "nascent state," which is, as Sir B. Brodie says, really a polar state; for when zinc and sulphuric acid act together in the presence of water, hydrogen is evolved, and if any substance be present with which hydrogen forms compounds, for example, common arsenic or arsenious acid, $As_2\,O_3$, arsenuretted hydrogen and water are formed—

$$6\,Zn + 6\,(H_2\,S\,O_4) + As_2\,O_3 = 6\,(Zn\,S\,O_4) + 2\,As\,H_3 + (H_2\,O).$$

Whereas, no arsenuretted hydrogen is produced if the hydrogen be passed over arsenious acid in the cold; in fact, no reaction takes place, and simply metallic arsenic and water are the products if the arsenious acid be heated while submitted to the action of free hydrogen.

LYELL'S GEOLOGICAL PHILOSOPHY.

Sir Charles Lyell may well be congratulated on bringing out the tenth edition of his "Principles of Geology." In his preface to this edition he tells us that it is now thirteen years and a-half since the ninth edition made its appearance, and he has found it necessary to re-write some chapters, to modify others, and to omit passages no longer conforming with the best views of the day. The "Principles" made their first appearance in 1830—1833, and in 1834 a re-publication of the whole with new matter was issued in four volumes. Looking back to these dates, the science which Sir Charles has so ably expounded, and to which his own researches and methods of thought have contributed so much, appears in a widely different condition to what it is at present. Only a few bold thinkers ventured to reject Archbishop Usher's Chronology, or to differ from the orthodox views of the very recent creation of our globe and "all that it inherit," and the consequence was that geological theories were all founded upon the belief that changes, which are now known to have resulted from the slow operation of ordinary causes, were produced by violent catastrophes and convulsions, sweeping many plants and animals from our globe, as a sponge cleans the diagrams from a blackboard, and leaving the ground clear for any number of fresh creations that seemed to be required.

It is easy—and especially so with the help which Lyell's own researches into the history of geological speculation affords—to show that some previous thinkers had been impressed with the erroneous character of such spasmodic conceptions of the order of nature, but to him more than to any other philosopher in our own country, or on the continent, belongs the distinguished merit of marshalling facts and arguments so as to give a sound direction both to the theoretical and the practical part of the science. So long as observers were content with irrational endeavours to account for all the facts they met with, by ascribing them to forces of tremendous violence operating in very brief spaces of time, the supposed geological past bore only a very faint resemblance to the actual present, and the different portions of terrestrial history conformed to no known or intelligible plan. We now know that although various sciences may be made to throw combined light on each other's paths, that each natural group of facts must be studied independently, and no generalizations admitted which they do not fairly warrant. The known facts of geology, fifty or a hundred

years ago, did not warrant the generalizations they were affirmed to support. Nothing actually seen or traced on the globe pointed to a beginning a few thousand years ago, or to the universality of one great deluge. Both those propositions belonged to another sphere of thought, and according to a logical method of procedure would never have been admitted as geological axioms. Finding the remains of water creatures, shell fish, etc., in vallies, on mountains, and in deep cuttings, would naturally have led to the thought that there was a time, or rather that there were times, when what is now dry land was river bed or sea bottom, but the orderly arrangement of many formations in which these relics of the past occurred should have contradicted the notion that a great deluge had done all the work, and would have done so long ago, if geologists had been true to their own science.

The study of existing causes was in a very imperfect state when Lyell began his labours. Not only had the facts to be accumulated concerning the action of rivers, floods, sea waves, rains, volcanoes, earthquakes, etc., at the present time, or within historical periods, but it was necessary to institute careful comparisons between their known effects and the appearances exhibited by formations of earlier date. This latter part of the inquiry was sadly hindered by the tendency to ascribe too much importance to negative evidence. If Lyell's views of the sufficiency of existing causes to account for all the formations the geologist can gain access to, were correct, the various groups of rocks and fossils which had been unfortunately named "primary," "secondary," and "tertiary," ought to stand to each other in regular family succession, and the younger formations ought to appear as the legitimate descendants of those preceding them. But the observed facts did not exhibit an orderly development of this kind. It seemed as if systems had passed away and other systems had arisen in a manner not consistent with orderly progress. The connecting links which Lyell's philosophy pre-supposed were frequently wanting, and in no way did he more conspicuously or brilliantly exhibit the true scientific spirit than in his resolute refusal to give undue weight to negative evidence. He argued that if the links had not been discovered they might hereafter be found, that we know far too little of the earth's structure to be entitled to assume non-existence from non-discovery; and research continually added to the proofs that past phenomena were explicable by reference to existing causes.

Most abundantlyhas the progress of field geology confirmed the anticipations of the great thinker to whose labours so much honour

is due. Link after link has been traced, and what is of scarcely less importance, strong proof has been found to show that an immense number of intermediate formations not yet discovered, must have existed, so that we are not entitled to assert that in any portion of the series, there were either violent breaks or violent alterations in the general plan.

The successive editions of Sir Charles Lyell's "Principles" have been proofs of the soundness of his method of inquiry. The new facts, while exploding other theories, have, in the main, established his, and when he has found most reason for changing or modifying particular opinions, he has been influenced by discoveries that have strengthened his main system. Thus, in early editions we find him a strong opponent of development theories, and yet when Darwin's great work appeared he was one of the first supporters of the doctrines it maintained. He would, no doubt, have exhibited more of the prophetic character if he had more accurately distinguished between the errors of speculations like those of Lamarck, and the fundamental truth which they imperfectly endeavoured to elucidate. Tested, however, by the action of existing causes the development theories of the pre-Darwinian period did not appear sound. Darwin for the first time brought an important group of existing causes into logical connection with past facts. He did for the organic world what Lyell had done for terrestrial rocks, and if the work was less complete it was because the subject was more difficult. Some sort of development theory is logically essential to Lyellian geology, and Sir Charles frankly accepted the first that came with sufficient evidence of its probability.

We have so recently discussed the Darwinian theory, and, in the INTELLECTUAL OBSERVER, we took so many opportunities of laying before our readers the most important discoveries recently made by geologists, that we need not follow Sir Charles Lyell in his elaborate and varied expositions. We find, in this new edition of his "Principles," an admirable *resumé* of recent facts and speculations, and we would especially recommend attention to the chapters on changes of terrestrial climate, and to the provisional attempts to arrive at the real date of certain formations. At p. 251, vol i., we find a very instructive map, showing the extent of surface in Europe known to have been covered by the sea since the commencement of the eocene period—a very distant date, if we could state it in historic time, but a geological yesterday, though, perhaps, millions of years ago. Spain, though presenting a solid mass of older land, was, at one time, since that epoch, divided by a sea from France. A great

sea may have stretched from Berlin and Dresden, through Poland, Finland, past Moscow and St. Petersburg to the White Sea, and through Denmark and Sweden, leaving the high land of Norway. The Black Sea and the Caspian may have been united at the time when the lower lands on the Volga and the Danube were submerged. What proportion of land was above water at any particular time, is very difficult to ascertain; but a mere inspection of this instructive map is sufficient to show that the climate of Europe must at certain periods, since the eocene epoch, have differed considerably from what it is now. As Sir Charles Lyell says, "some approximation has been made to an estimate of the amount of *sea converted into land* in parts of Europe, best known to geologists, but we cannot determine how much land has become sea during the same period, and there have been repeated interchanges of land and water in the same places, of which no account could be taken."

Lyell regards our existing continents as very ancient, notwithstanding minor modifications; but the term "ancient" has reference to chronologic rather than to geologic time, as even in the eocene period "the distribution of land and sea bore scarcely any resemblance to that now established."

The depth of the sea is much greater than the height of the land above it, and this fact exercises an important influence on the rate at which certain modifications take place. "The mean height of the land is only 1,000 feet, the depth of the sea, 15,000 feet. The effect, therefore, of vertical movements, equalling 1,000 feet in both directions, upward and downward, is to cause a vast transposition of land and sea in those areas which are now continental, and adjoining to which there is much sea not exceeding 1,000 feet in depth. But movements of equal amount have no tendency to produce a sensible attraction in the Atlantic or Pacific Oceans, or to cause the oceanic and continental areas to change places. Depressions of 1,000 feet would submerge large areas of existing land, but fifteen times as much movement would be required to convert such land into an ocean of average depth." Assuming that the average quantity of land and sea remains pretty much the same, and that the distribution of land and water is continually, though slowly changing, the condition of things may vary between a maximum aggregation of land on the equator, and a maximum at the poles, with sea at the poles in one case, and land at the other. The first would produce the warmest average of climate, and the latter the coldest, while between them all kinds of variations might occur. At present we seem "much nearer to the winter than to

the summer of the *annus magnus*, or great cycle of terrestrial climate."

Sir Charles Lyell discusses with great ability the climatic effects of astronomical changes, such as the inclination of the earth's axis, the occurrence of summer when the earth is nearest the sun, instead of when furthest, as at present, and many similar matters; and shows that, on the whole, variations in the distribution of land and water would be far more potent causes of vicissitudes of climate.

A very striking hypothetical section relates to the probable "comparative duration of the glacial and the antecedent tertiary, secondary, and primary epochs." If the glacial epoch was coincident with the last maximum eccentricity of the earth's orbit, as suggested by M. Croll, and with our northern winter's occurrence at the greatest distance from the sun, it is found from astronomical calculation that the epoch in question may have commenced a million years ago, and reached a maximum 210,065 years ago. But the marine shells of the glacial period, as compared with the present ones, show a change of only five per cent.—ninety-five per cent. being specifically identical with that of living animals. Thus one million of years would correspond with one-twentieth part of a complete revolution in marine species. In the older miocene formation, the marine shells, as a whole, differed from those now existing, and their date would, on this calculation, appear to be twenty millions of years ago. Between them and the beginning of the Cambrian period twelve similar changes may be traced, and thus the commencement of that period would be carried back 240 millions of years.

We give this merely as an illustration of the enormous demands upon time which modern speculations make, but looking to the probability that variations in the disposition of land and sea, according to laws not yet elucidated, had much more to do with changes of climate and species than any astronomical agencies, little weight could be attached to a calculation based on the latter class of facts. But other methods of reasoning do not lessen the probability that the series of modifications which we trace in successive formations, took place with extreme slowness, and with what, to our feeble conceptions, must appear a gigantic expenditure of time.

If science modifies theology, it cannot be said to imperil religion. It opens a grander perspective of creation than ignorance could have conceived. As Lyell observes, the more the idea of a slow and insensible change from lower to higher organisms, brought about in the course of millions of generations according to a preconceived plan, has become familiar to men's minds, the more conscious

they have become that the amount of power, wisdom, design, and forethought required for such a gradual evolution of life, is as great —might he not have said greater—"as is implied by a multitude of separate special and miraculous acts of creation."

Referring to the unwillingness to accept new ideas, so characteristic of barbarism and so detrimental to the progress of civilization, he remarks, "we are sometimes tempted to ask whether the time will ever arrive, when science shall have obtained such an ascendancy in the education of the millions, that it will be possible to welcome new truths, instead of always looking upon them with fear and disquiet, and to hail any important victory gained over error, instead of resisting the new discovery long after the evidence in its favour is conclusive."

Sir Charles Lyell has happily lived through a period in which great improvement has taken place in this respect, and he stands foremost in the ranks of those to whom society is indebted for the beneficial change. No science has done more than geology to emancipate the human intellect from superstitious trammels, and no other geologist has done so much to place that science upon a firm basis of sound theory and philosophic truth.

MARKINGS ON THE PLANET VENUS.

BY JOHN BROWNING, F.R.A.S.

On the afternoon of the 15th of March, I had been observing a remarkable group of sun spots, with a 10¼-inch silvered glass reflector. About half-past four P.M., the sun becoming partially obscured by some trees, I set Venus off upon the circles of the equatorial, and looking along the tube I saw that she was plainly visible to the naked eye, although the sun was shining brightly. Viewing the planet with a power of 185, I found definition above the average. The feature that first attracted my attention was a curious oblong white nebulous spot, of considerable dimensions, shining with far greater brilliancy than any other part of the disc. This spot was on the edge of the disc, and fully 80° from the southern horn. From the resemblance it bore to the cloud-like patches I have described on Mars (INTELLECTUAL OBSERVER, September, 1867), I have little doubt that this spot was a highly reflective cloud in the atmosphere of Venus. Being within 10° of a line from the centre of the planet to the centre of the Sun, it was, of course,

in a position to receive the utmost amount of light from that luminary.

The northern horn was slightly blunted. More commonly the southern horn is shortened, but this doubtless depends on the phase. A trace of light was perceptible along the limb beyond the southern horn. The gradation of light from the terminator extended across one-third of the visible disc, the illuminated portion being about seven-tenths of the whole disc. Looking intently at the partially illuminated disc near the terminator, I was able to make out that the surface of the planet was covered with markings bearing a resemblance to the grey plains on the Moon. These dark markings seemed to be studded with white spots of various sizes. In fact the shaded part of the planet looked very like the Moon when three-quarters old, seen with an opera glass of low power through a thick mist.

Mr. De La Rue once mentioned to me that he had occasionally seen faint markings on Venus with his large reflector, but with this exception, I had never heard that any observer had recently succeeded in seeing them. During the last week, however, I have heard from Mr. With that using a 12-inch glass reflector, *unsilvered,* he has seen a cluster of bright spots at the S. limb, about 40° from the terminator. I find a white patch in nearly the same place on my own drawing. I have also heard from Mr. Huggins that he has, only a few days since, seen a good sized white spot near the N. horn on the terminator. The actual existence of such markings may therefore, I think, now be considered as tolerably well established.

Observers with *small* achromatics may hope to make out the markings, but with large apertures, Venus is a much easier object in a good reflector than in a refractor, the reason being that the reflector has no aberration of colour. I have previously referred to the method of using an unsilvered glass mirror. A silvered mirror may, however, be used with a solar eye-piece, containing a single surface-reflecting prism.

Such an arrangement gives as good results as an unsilvered mirror, and possesses the great advantage that it leaves the telescope unaltered for any other class of observations.

MICROSCOPICAL NOTES.

The *Soirée* of the Royal Microscopical Society, on the 22nd ult., at King's College, was the most brilliant and successful the Society has given. The leading makers were well represented, and many objects of scientific, as well as popular interest, were exhibited. On another occasion we should advise that a larger number of Fellows should become exhibitors, and the excellent display of microscopes and objects by the Society, may be advantageously followed up on subsequent occasions.

A tank microscope by Mr. Ross, an adaptation of Nachet's pseudoscopic binocular, by Messrs. Murray and Heath; a new meteor-spectroscope with an enormous field, and a new reflecting goniometer by Mr. Browning, a remarkable clever and elegant adaptation of the kaleidoscope to the oxy-hydrogen lantern by Mr. How; Mr. Ackland's alcohol thermometer and optometer, and Fiddian's lamp chimney, of which we have lately spoken, by Mr. Collins, were among the principal instrumental novelties. Mr. Ladd exhibited his magnificent specimens of Iceland spar. The list of objects was decidedly above the average, both in point of beauty and scientific interest. Dr. Carpenter brought a beautiful series to illustrate the development of the Ophiuridæ, and we might specify many others who brought new and rare things. Much interest was excited by the opportunity for comparing a beautiful collection of early microscopes, belonging to the Society, to King's College, and to Mr. Williams, with the modern instruments. The famous "Martin microscope" was arranged to show a splendid specimen of crystallized bismuth belonging to Mr. Williams; with a power of about five inches it took in an object 1¼ in. diameter. The Society did well to show some fine specimens from the "Beck collection" of bone sections recently presented, and objects from the Wallich collection, and from other of its late acquisitions.

Last year Stein published the second part of his great work "Der Organismus Der Infusionsthiere." It is a handsome folio about the size of those issued by the Ray Society, illustrated by sixteen well-executed copper plates, containing numerous figures. Compared with similar English publications its price is very high, which must seriously limit its sale. It consists of two divisions, the first detailing the latest investigations into the structure, reproduction, and development of Infusoria, and the second describing

those organisms which the author arranges under the order *Heterotricha.* Making the ciliary apparatus the basis of his classification, Stein recognizes five great orders of Infusoria, Peritricha, Hypotricha, Heterotricha, Holotricha, and, lastly, the "whip-bearers" (*geisseltragenden* species), or Flagellate Infusoria. The Acinetans he places between the two last. The Opalina, Trachelina, Enchelina, Paramecina, and Cinetochilina, have "the common character, that their entire bodies are uniformly ciliated, and that they have no oral ciliary zone." These form the Holotricha. Bursaria, Stentorina, and Spirostoma, like the preceding, have the entire body ciliated, and in addition they possess long powerful mouth-surrounding cilia—these are the Heterotricha.

Oxytrichina, Euplotina, and Aspidiscina have, for the most part, flattened bodies, with distinct dorsal and ventral sides, and the ciliation although varying in different families, is always confined to the ventral surface. These constitute the Hypotricha.

Vorticellina and Ophrydina, the Urcolarians, Tintinmus, Halteria, etc., have a zone of mouth-surrounding cilia, but not ciliated bodies. This division—the Peritricha—is not as well defined as the preceding.

It will be seen that whatever difficulties may occasionally occur in the classification of objects according to this system, it is simple and clear. M. Claparéde commenting upon it in the "Archives des Sciences," pronounces it a very natural classification, and expresses the belief that it will be generally approved.

With reference to the Acinetans, Stein has completely abandoned his well-known theory. After citing observations on their development, he says, "The Acinetans do not therefore belong to the development cycle of the Vorticellians, and as little do they to that of any other Infusoria; they are doubtless self-complete organisms. My Acinetan theory is laid aside."

M. Claparéde observes on this passage that it was very easy to make Stein's mistake, "the fact that the embryos of many Infusoria are furnished with suckers like those of the Acinetans readily led to the seductive hypothesis." Stein himself is quite entitled in withdrawing this hypothesis, to claim for it the merit of having promoted inquiries by which our knowledge has been largely increased. We purpose recurring to his book on several future occasions, and for the moment pass to other matters.

We have received from the authors an extract from the memoirs of the Societa Italiana de Scienze Naturali, entitled "Nota Sopra un Alciopede Parassito della *Cydippe densa, Forsk.,*" by Professors

Edouardo Renato Claparède, of Geneva, and Paolo Panceri, of Naples. They tell us that, while pursuing their researches among the numerous oceanic creatures brought by the currents into the Gulf of Naples, they met with elegant Beroids, which they believe corresponds with the *Cydippe densa* of Forskall, and which Gegenbauer describes under the name *C. hormiphora*. In some individuals of this species they noticed little bodies, which they at first took for tailed larvæ of a distoma; but the presence of others somewhat larger, and of small annelids alive in the stomach of the Cydippe, led to further investigation, and to the recognition of the creatures as belonging to the family Alciope. In their first stage these larvæ were about one millimeter in length, and the head was not distinct from the body, and was without appendages. The eyes were not protuberant, and were represented by a round crystalline lens, with a pigment layer behind it. In this condition it is represented in their plate as an oblong body slightly rounded and protuberant at the sides, with the tufts of cilia on each side. Their plate represents seven stages of growth in a very interesting manner. The eyes grow larger and more protruding, antennæ are developed, and the body exhibits numerous segments with rows of bristles. "The larva in the ultimate stage of our observations contained about thirty segments. The head exhibited the superior antennæ elongated and protruding, while the lower ones remained as tubercles. The eyes, more developed, had the form of those of adult Alciopi, and could be moved in various directions in connection with the head segment."

In this stage their figure represents the creature as having its body tinted with a delicate blue, the choroid of the eyes orange-yellow, the lens bluish. On each side of the back is a row of dark pigment spots, one for each segment. The feet, except the lower ones, are bristled. Length about one centimetre. From the development of the eyes and feet the authors consider that this creature, which they name *Alciopina parassitica,* could only be an internal parasite as a temporary arrangement. The situation, they think, might be favourable to the growth of their organs. In a note they say that M. Buchholz, of the University of Grieswald, had discovered in a Cydippe a larva of the same genus.

We have also received from Professor Claparède "Observations sur les Rotateurs," from the "Annales des Sciences Naturelles." This paper contains many interesting observations, but we must now content ourselves with citing one. It refers to the *Melicerta ringens,* and its method of producing the currents which bring in

its food. "At the lower surface of the membranous vibratile organs of the Melicertæ there rises a crest, also membranous, which runs parallel with the margin of the organ, at a little distance from it. We may consider the vibratile organ as formed by a membrane doubled on its own margin in two plates, the upper one projecting notably beyond the lower one. The space between these two makes a deep channel, running all round the vibratile organ. The border of the upper plate carries the large cilia, which produce the illusion of rotating vessels. That of the lower plate also bears cilia. They move also, but their motion is very different from that of the upper cilia. They scarcely give rise to any optical illusion. The point of each cilium beats continually in the same plane, parallel to the margin of the apparatus; but the direction of this movement is inverse in the two halves of the vibratile organ." It is when a particle, entangled in the whirlpool of the upper cilia, touches the point of a lower one that its course is changed, and it is brought into the channel already mentioned.

We have also to thank M. Claparéde for a paper on the reproduction of plant lice.

ARCHÆOLOGIA.

About three-quarters of a mile to the north of Cockermouth, near the spot where the river Cocker enters the Derwent, is the site of a Roman station, not far from which is the village and mediæval castle of Papcastle. The castle was partly built of the materials taken from the station, and among inscribed stones found here was a fragment of an inscription referring to some event which took place on the Kalends of November, in the year when Gordian, a second time, and Pompeianus were consuls, answering to the 19th of October, 241, according to our reckoning. From another fragment of an inscription, we learn that this place was occupied by a troop of Frisians from Aballaba, for this seems to be the meaning of the words NVMERVS FRISIONVM ABALLAVENSIVM. At the date of the Notitia Imperii, the station of Aballaba (supposed to be Watch Cross), was occupied by a *numerus*, or troops of Moors, but it may perhaps, at an earlier date, have been occupied by Frisians, who had been removed to the station at Papcastle, the Roman name of which is not known.

During the last six months, Papcastle has been the scene of a considerable amount of excavations, done for the sewerage and

water-works, in the course of which very numerous relics of the Roman period have turned up, many of the smaller and more interesting of which were purchased and carefully preserved by Mr. Henry T. Wake, of Cockermouth. Among these were a quantity of leather, chiefly parts of shoes, one of which was a sole covered with very large-headed nails, in excellent preservation, resembling examples from Roman London collected by Mr. C. Roach Smith. None of the shoes were perfect, but some of the leather bears a resemblance to morocco, and other pieces to cordovan. One piece is distinctly stamped VICTC. Among the personal ornaments were several brooches, some of them peculiar in their character. One of them, which was round, and about the size of a modern bronze penny, bore distinct traces of blue enamelling, and an ornamentation of black dots, etc. It had a small boss in the middle, resembling in form the boss of an Anglo-Saxon shield. Other bronze fibulæ, all remarkably well preserved, presented well-known Roman forms; and several rings, mostly in bronze, beads, etc., were found scattered about. Among them was a small glass bead, of very delicate make. Pottery was found in great abundance, but nearly all in fragments. Some of the Samian ware was much ornamented, presenting figures of men and women, animals, mythological subjects, hunting scenes, etc. On one of the pieces of Samian ware the potter's stamp was SATVRNNI OF; two others were MAMMI, and FRI.CI MA, the first letters of the latter being lost. On a piece of one of the coarser sorts of pottery the letters PIRV were scratched. There were also examples of some classes of Romano-British pottery of rarer occurrence—some perhaps of rather a late date in the Roman period. One, which was found entire, is jug-shaped, with a handle, not unlike examples found in Anglo-Saxon graves. Fragments of glass were also found, but they were not very numerous. Among other objects were, a steel awl, five inches and a half long, in fine preservation; a steel punch, four inches and a quarter long; a whistle, made from a shank bone, with a hole neatly drilled through it; two counters of bone, with a bevelled edge, having a smooth surface with lines forming geometrical figures on one side, and a small hole in the centre of the other; and many iron nails, some of them of very curious forms. Among the more remarkable of the miscellaneous objects are two singular bronze discs, or dishes, both covered with green rust. The smaller example is ornamented with engraved lines, forming on the upper surface, or field, a pattern of concentric circles; it is two inches in diameter. The larger dish, which is three inches and one-eighth in diameter,

stands upon three ring-formed legs, and has in the centre of its field what appears to be the remains of an upright spike, which would lead us to suppose that it may have been a candlestick. Among the coins found in these excavations were a silver denarius of Nerva, much worn, and a denarius of base silver and another coin in second brass of Faustina junior, both in fair condition; but the others were mostly illegible. Among other things, a great quantity of oak timber was met with, in beams and boards; and, among animal remains, a boar's tusk, and some teeth, and numerous bones of oxen, deer, etc., some of them perfect, but others broken into pieces.

In trenching some ground recently at BERWICK-UPON-TWEED, in a place called the Inner Cow Close, a number of early sepulchral interments were found, apparently belonging to a regular cemetery. On each side of three of the skeletons were slabs of undressed stone, with rude stone coverings, on one of which was an incised cross, with a rose in the centre; on another, which was the cist of a child, there was a Latin cross. In another part of the ground the foundations of a tower-like building, of sound masonry, were discovered, in front of which was a wall four feet thick, which was traced to a distance of ninety-four feet long. The tower-like building was twenty-three feet square, and there was a space of twenty feet between it and the wall. The masonry was pronounced, we know not on what authority, to belong to the Norman period.

Interesting discoveries have been recently made in the ruins of GUISBOROUGH ABBEY, in Yorkshire, in the course of excavations directed by Captain Chaloner, the present proprietor of the estate. A trench was carried across the site of the church at about 200 feet from the east window, in a line with the outer wall, and a large doorway, with the remains of early English pillars in Purbeck marble, was discovered, probably an entrance from the church into the quadrangular court. Among the great mediæval barons whose bodies were interred in this part of the church, was Robert Bruce, Lord of Annandale, the competitor for the crown of Scotland with John Baliol, who died in 1294. In the course of the present excavations, there was found immediately before the high altar a quantity of heraldic tiles bearing the arms of Bruce, and a few inches beneath the pavement, in the very centre of the choir, at the foot of the steps on which the high altar is presumed to have stood, a stone coffin, six feet eight inches by two feet two inches, which may perhaps have contained the remains of Baliol's competitor. The skeleton was that of a tall and aged man, and its identification is

not very certain, for it may have been that of the founder of the monastery, an earlier Bruce, who fought in the ranks of King William at Hastings, and was the head of the great family of Bruce in the north. About twelve feet from this spot lay another stone coffin, with a complete skeleton in it. The heraldic tiles discovered in this part of the church were of great beauty, and many of them of no inconsiderable interest. The ruins of the central tower were found just as it had fallen, and under the masses of broken masonry were three large monumental slabs. At the depth of five feet from the surface, in the remains of an oak coffin, lay a skeleton which is stated to have been found, on careful measurement, to have been six feet eight inches in height. With it were found two circular bronze buckles, like those displayed in the heraldry of the fourteenth century.

T. W.

PROGRESS OF INVENTION.

Arrangement for Hanging Pictures.—A very simple arrangement has been patented and one which seems to offer many advantages over the very unsightly method now in use. A long piece of sheet iron, the length required for the side of the room, a few inches wide, is bent in the direction of its width in a semicircular or other ornamental form, but its lower edge is turned up the whole length sharply, so as to form a receptacle for hooks which can be hung on to it, at any distance apart; to these hooks, the cords by which the pictures are hung, are fixed: the hooks may be made very ornamental in stamped metal, or in any other way according to taste. The whole length of bent iron is fixed to the wall by wood plugs; a thin casting would answer equally as well as sheet iron, and both can be ornamented with stamped brass, embossed and decorated paper, or by decorated designs in gold and colour. The whole might be made to supplement the room cornice, and placed at an interval below it, would form a sort of frieze which might have its special decoration. The concave side of the iron bar is of course to be turned to the wall, the outer which faces to the room having the appearance of a moulding. This invention seems to afford a means for wall decoration in good taste, in lieu of what has hitherto been an unsightly makeshift. The name of the inventor is W. Potts.

Improvements in Numbering Hall Doors.—Who has not felt the annoyance of having to ascend flight after flight of steps on a dark night to ascertain the number of the house which he intends visiting? Messrs. Drury and Westrup have patented a method by which this annoyance

may be removed in a very simple and efficient manner, and without in any way disfiguring the street door. They propose to have the knocker so made, that, in the upper part of its scutcheon an open space shall be left, forming a sort of medallion, in this is to be placed a piece of ground or opaque white glass, on which the number of the house is to be painted in black figures. They will be conspicuous by daylight, but much more so at night, when the gas is lighted in the hall, as they will act as a transparency. It is easy to see how such an arrangement can be readily made an ornamental feature. Where bells are used instead of knockers, the medallion can be made separately and fixed to the door in the most approved situation. Of course in both cases the part of the woodwork behind the medallion must be cut away to allow the light to shine through the glass at night. Where desired the name of the occupant, can be added to the number of the house. It would be well if parish authorities would have the number of the nearest house at the corner, where two streets join, marked legibly on the glass of the gas lamps, and also the name of the street; this improvement together with Messrs. Drury and Westrup's invention would do much to render evening visiting less difficult than it is at present.

Hydraulic Self-Acting Vent Peg.—The servant has left out the vent peg and so six or seven gallons of beer are comparatively spoilt, at least the pleasure experienced in drinking them is very much lessened. Mr. E. T. Hughes has put into our hand a remedy for this evil, and one which the most careless and stupid servant would have some trouble to render of no effect. He makes a small cylinder, open at the top, closed at the bottom, inside which is placed a smaller tube passing through the bottom of the cylinder to which it is soldered water-tight. Here we have tube within tube, the inner or smaller one projecting below its outer covering two or three inches, and this projecting part is made to taper, so that it may be fixed into the beer barrel; the outer cylinder is pierced with holes, rather above its middle, and water is poured into it, between it and the smaller tube; the water of course cannot stand at a higher level than the holes. A small metal bottle is made with an orifice rather larger than the smaller tube, over which it is placed bottom upwards, the small tube projecting into its interior: there is therefore communication between the inside of the barrel, and the inside of the bottle by means of the small tube, and the density of the air in both vessels will be the same. Now when liquid is drawn out of the barrel, the air in it will be rarefied, and so will that in the bottle of the vent peg, and as the orifice of this dips into the water between the two cylinders but a short distance, the air outside will force its way through the water into the bottle and then to the barrel, and no more will pass in than is sufficient to take the place of the liquid which has been drawn out.

LITERARY NOTICES.

Celestial Objects for Common Telescopes. By the Rev. T. W. Webb, M.A., F.R.A.S., Incumbent of Hardwick, Herefordshire. Second edition, revised and enlarged. (Longmans.)—By universal consent of observers in this country, Mr. Webb's "Celestial Objects" has taken the place of a standard text-book, and its value will not be lessened by the promised second edition of Admiral Smyth's larger and costlier work. In the present edition Mr. Webb has added angles of position to his list of double stars, and has given three new appendices: the first, containing the names of all the principal lunar objects, arranged alphabetically; the second, supplying a list of objects in the southern hemisphere, selected from Sir J. Herschel's observations; the third, exhibiting all the stars, etc., mentioned in the body of the work, arranged in order of right ascension, corrected to 1870. In other respects the changes introduced in this edition are very slight, but we notice an interesting sketch, copied from Pastorff, of the transit of the comet of 1819 over the sun, and an instructive view of the extinct crater of Haleakala, to illustrate the resemblance between lunar and terrestrial volcanoes.

As English observers are much indebted to Mr. Webb for the judicious pains he took to introduce silvered mirror telescopes, we are surprised that he did not amplify the chapter on the telescope to say something about them. With a book so well known and so highly appreciated, we have little more to do than to mention the appearance of a new edition, which we know has been wanted for some time, and which those who survey the glories of the heavens will be anxious to obtain.

Man's Origin and Destiny, Sketched from the Platform of the Sciences: A Course of Lectures delivered before the Lowell Institute in Boston, in the winter of 1865-6. By J. P. Lesley, Member of the National Academy of the United States, Secretary of the American Philosophical Society. (Trübner and Co.)—The subject which Mr. Lesley has undertaken to elucidate might well occupy the lifetime of a great scholar and a profound thinker. To sketch "Man's Origin and Destiny from the Platform of Science" would demand the highest qualifications, the most accurate treatment; and, when attempted in eleven slap-dash lectures, full of slang and vulgarity, the result cannot be of a very satisfactory kind. That Mr. Lesley has brought together a considerable mass of information will not be denied. He seems an omnivorous reader, and always ready to be an universal expounder. Geology, astronomy, architecture, language, ethnology, or theology, it matters not which—he can talk about any, or discourse upon all in a rushing, voluble, helter-skelter style, perfectly unsuited to a serious subject, and horribly offensive to good taste. That such methods of dealing with questions of great moment should have been tolerated at the Lowell Institute excites our surprise, and that after two years' time for reflection their author

should deem them fit for the press, indicates an astounding power of self-satisfaction, and inability to perceive glaring defects.

To glorify the present, Mr. Lesley indulges in preposterous deprecations of the past. Ancient science, he declares, had "no purpose in its investigations, no use in its results." "The mathematics of the ancients," we are told, "could produce nothing higher than astrology." Of course it does not matter for this sort of disquisition that Hipparchus discovered the precession of the equinoxes, catalogued the stars, and calculated the motions of the sun and moon. The "only intellectual tool above the level of their senses, which the ancients had to work with," Mr. Lesley discovers "to have been their quick and fertile imagination.' A gentleman who views the past in this way is not likely to be a very accurate guide to the present, or a sound prophet of the future. In treating modern science, though many things are stated with tolerable correctness, we notice the same raw haste in assertion, and a striving for effect. Then we are told of the members of the animal kingdom, "they are each and all perfectly and beautifully adapted to their circumstances—the mollusca to the water, the articulata to the air, the vertebrata to the land, and the radiates to the places and times where air and water meet." A moment's reflection, or reference to any text book, would have shown the absurdity of this attempted division. Land mollusca, non-flying articulata, and aquatic vertebrata, are common enough, and well adapted to their mode of life. From Mr. Lesley's account of the matter, it might appear that all snails lived in the water; that crabs—which belong to the articulata—were in the habit of flying, and that fishes were destitute of vertebræ.

As a mild specimen of the vulgarities of the book, take the following: "One kind of blood is metal to the acid of another; mix them in generous proportions, and you have Hare's calorimoter on a cosmical scale; you can burn up with it the past, or electrotype with it the future. When the effervescence ceases, the creator walks away. The apparatus is useless until it is charged anew." Or this mode of telling the story of Pelops—"His prime offence was that of divulging to mortals the secrets of the Gods. His second offence was the diabolical trick which he played upon his Olympian guests, in cooking his own boy Pelops, and serving him up as a ragout, to see if their omniscience would discover what they really ate. Mercury restored the boy to life. . . His fresh beauty now ravished the heart of Neptune, who carried him in his own golden chariot to the top of Olympus, until the rest of the enraged deities, after a furious knock-down and drag-out fight in the royal dining-hall, had settled his father's hash; then he was carried back to rule in his father's stead." Notwithstanding a certain sort of cleverness, we fear Mr. Lesley's "hash" will be deemed bad cookery by any judge of decency or taste.

NOTES AND MEMORANDA.

New Reaction of Albuminoids.—It is stated, in the "Ann. der Chimie. et Ph.," that sulphuric acid containing molybdic acid colours the above-named matters an intense blue. Grains of wheat cut through the middle, and muscular fibre exhibit it.

Giant Synapta.—M. Semper, in his "Reiser. im Archipel. der Philippinen," describes creatures of this kind five, and even seven, feet long. The natives call them "sea-serpents." He states that the "anchors," so well known to microscopists, are not organs of locomotion, and are not under the control of voluntary muscles.

The Carboniferous Rocks of Pendle Hills.—Mr. Hull recently communicated a paper to the Geological Society on the above formations. He considers the aggregate thickness of the coal-measures, the millstone grit, and the Gordale series, to be 18,635 feet in the Burnley district, while in Leicestershire it has dwindled down to 3100 feet. The source of these sediments he thinks to have been a primæval Atlantis, a view which he considers to be strengthened by the fact that the carboniferous sedimentary strata of North America also swell out towards the north-east, and become attenuated towards the south and west.

Growth of Mineral Veins.—"Proc. Roy. Soc.," No. 100, contains a paper by Mr. J. A. Philips on the Gold Fields of California, in which, among other matters, he describes the growth of mineral veins, about seven miles from the Comstock silver mine, in the State of Nevada, in which boiling springs are active. One group of crevices in the rock comprise five longitudinal springs, extending in parallel lines for more than 3000 feet. Sulphur, silica, and anhydrous oxide of iron are deposited; the silica and iron forming semi-crystalline bands. Another fissure exhibits a silico-metalliferous deposit. He arrives at the conclusion that quartz veins have generally been produced by slow deposition from aqueous solutions of silica. That gold may be deposited from the same solutions appears from the presence of that metal in pyrites enclosed in silicious incrustations, as well as from the fact of large quantities of gold having been found in the interior of the stems of trees, which, in deep diggings, are often converted into iron pyrites. Mr. Philips thinks the sulphide of iron may be in some way connected with the solvent by which the precious metal is held in solution.

Formation of Asphalt.—M. Knab affirms, in "Comptes Rendus," his belief that the asphalt of the Val de Travers, Switzerland (or limestone impregnated with bitumen) was formed by beds of mollusks decomposed at a high temperature, and under great pressure, in a deep sea. Free bitumen he thinks formed by a similar decomposition, but at a pressure insufficient to force it into the shells of the mollusks. Petroleum he regards as formed in the same way, at a lower temperature, but under considerable pressure. Beds of fossil oysters, without bituminous matter, he supposes to have been under conditions which allowed the hydrocarbon to evaporate.

Fossil Coot from the Mauritius.—Mr. Alph. Milne Edwards read a paper before the Academie des Sciences, describing a recently discovered fossil coot (Fulica) from the Mauritius. The bones indicate a bird of much larger and heavier structure than those of existing species, and resemble *Fulica gigantea* more than any other.

Two Types of Horse.—M. A. Sanson states, in "Comptes Rendus," that there are two distinct types of horse hitherto confounded under the designation Arab or oriental. They are both Brachycephalus, and have their origin in different geographical districts, and are of different race. The oriental or Asiatic type has six lumbar vertebræ, the Arabian or African has only five, which is the number found in the ass or zebra.

BAOBAB,

[illegible] feet in circumference, at Nyaruka Village, on the Zambesi, South East Africa. November 11, 18[illegible], 4 p.m.

THE STUDENT,

AND

INTELLECTUAL OBSERVER.

JUNE, 1868.

THE AFRICAN BAOBAB.

(ADANSONIA DIGITATA, L.)

BY JOHN R. JACKSON, A.L.S.,

Curator of the Museum, Royal Gardens, Kew.

(*With a Coloured Plate.*)

THOUGH the Baobab is not a new discovery, there are so many peculiarities attached to it and to its Australian relative, that we are led to believe some description of these trees will not be without interest to the readers of THE STUDENT. We therefore intend to devote two papers to their consideration, and these will be the more acceptable from the introduction of the numerous notes which my friend Mr. Baines has furnished me with, on the localities where he has seen and sketched the trees, during his travels both in Africa and Australia. Adansonia is a genus named by Linnæus in honour of Michael Adanson, a French botanist, who travelled in Senegal between the years 1748 and 1754. It belongs to Bombaceæ, a sub-order of Malvaceæ, and includes only two species, one an African and the other an Australian plant. It is to the African species (*A. digitata*, L.) that we wish to draw the attention of our readers in this paper.

The African Baobab is remarkable not for its great height, but for its immense girth, and the great extent of its spreading branches. Adanson measured several trees, the circumferences of which ranged from 65 to 78 feet, while the huge branches, measuring some 40 or 50 feet long, and whose ends touched the ground, sprang from the

main trunk at no greater height than 12 or 15 feet. He computed that a plant one year old would measure 1½ inches diameter, and be 5 inches high; at 30 years old, it would be 2 feet diameter, and 1 foot 10 inches high: at 100 years, 4 feet diameter, and 2 feet 5 inches high; at 1000 years, 14 feet diameter, and 4 feet 10 inches high; at 2,400 years, 18 feet diameter, and 5 feet 4 inches high; and at 5,150 years, 30 feet diameter, and 6 feet high. If these calculations were true, the trees would be considerably thicker than they are high. Who can venture to verify these statements, or to tell the ages of such trees as Adanson saw in his day, and modern travellers have frequently seen since? Two of the trees seen by the old French traveller had European names cut into their trunks, one bearing date of the fourteenth and the other of the fifteenth century. These names were sunk to a great depth in the wood, owing to the growth of the successive ligneous layers forming around them. That the trees attain an immense age is very evident. Humboldt speaks of them as the "trees of a thousand years," and considers the Baobab the "oldest organic monument of our planet." It is found growing all over tropical Africa and the East Indies. Its head quarters, however, is in Africa, and the trees seem to have been pretty abundant in the track of the Livingstone expedition. Dr. Livingstone tells us, in his African travels, that these trees, which are called Mowana trees in the Bechuana language, are the most wonderful examples of vitality in the country, and when the expedition came upon a dead one, some little surprise was created, after having read what Adanson and others believed, that the trees which they saw were alive before the flood. Mr. Baines, who was artist to the first expedition, tells me he believes they begin to appear a short distance above the low lands of the delta of the Zambesi.

Near the village of Shupanga a venerable tree stands, some sixty feet in girth, its branches twisted and gnarled, and resembling some monster oak of our own forests, excepting that it is thickly overhung with luxuriant tropical creepers. It is under this tree, we believe, that Mrs. Livingstone lies buried. Many fine Baobabs occur in the neighbourhood of Tette, and one, most singularly formed, stands almost in the very town. Tette is the chief town of the Portuguese on the Zambesi. It is about three-quarters of a mile square, and is situated on the south bank of the river, which protects one side of it; the other three sides are surrounded by a wall, with bastions defensible against musketry. Two streets run through the town, parallel with the river, the houses being built on elevated ridges, for the purpose of keeping them as high as possible above

the heavy vapours, in which the fever—often so fatal to African travellers—lurks, while the hollows between form the streets. The fort is a rough building, mounting six or eight guns of various calibre; none, however, larger than 9-pounders. There is a building used as a hospital, and there is also a church, which latter, as far as external appearances go, much more resembles a large thatched barn, but internally it is decorated with some degree of taste, and possesses a set of tolerably good images, life size, used for carrying in their processions during the religious ceremonies. Including the suburbs, Tette has a population of about 6000 people, the majority of which are natives. In the south-west side of the wall, which, we have before said, encloses three sides of the town, a breach of considerable size occurs, and outside this breach a large Baobab stands, or rather lies, for it appears to have grown in shallow soil over a rock eight or ten feet square, and when the surface was washed away by rains, the tree had no doubt fallen owing to the roots, which it had sent out on every side to embrace the rock, proving insufficient to support it. The base of the tree, however, is sufficiently large to cover the rock, and it retains a very perfect impression of its form; but the stem rapidly diminishes upwards to about seven feet in diameter. It is impossible to say how many years have elapsed since this tree fell from its normal position. It is not, however, uncommon to see the trees more or less in this condition. It is very probable that the fall may be gradual, owing to the great weight of the branches, together with the foliage and heavy fruits accumulating in the course of years, the softness of the wood also allows of the entire trunks bending to such a degree, and not breaking. Nor are the ordinary functions of vegetation at all impeded in trees which have assumed these grotesque forms. The circulation of the sap is carried on, so that the branches put forth their leaves and blossoms equally with the younger and more normally conditioned plants, though as regards young plants, travellers have remarked that very few are to be seen even in the parts where the old trees abound. Mr. Baines says of this particular tree at Tette, "I made a sketch of it, and Dr. Kirk obtained leave to cut a section, but we had no saw large enough to work across the trunk, nor if we had, could we have worked it in the soft wood, so saturated with sap, and the cutting out of a section with axes would have been a work of so much time and labour, that we could not spare hands for it."

Sometimes the trees assume a low stunted form, with short, swollen excrescences, apparently in place of branches, only a few

twigs shooting forth here and there. At other times, they may be seen exceedingly broad, and resembling masses of masonry more than the trunks of trees.

The magnificent tree shown in the plate stands in the village of Nyaruka, below Shupanga. The circumference of the trunk is about fifty feet, and some of the branches show a peculiar flattening of the sides, and proportionate increase of depth, which nature seems to regulate so as to enable them to bear the greatest possible weight. In the distance is seen a tree known as the "massaa," into which natives are throwing sticks to bring down the fruits, which are dried and preserved for food. One of the canoes of the country is also introduced. They measure about fifty feet long, and four or five feet wide and deep, and are cut from a solid log. Through Damara or Namaqua land, from Walvisch Bay across to the west coast of the Zambesi, the Baobabs seem to be scant, and in many places to disappear altogether. This is particularly the case in latitude about 22°; but as Lake Ngami is neared from this direction, in lat 20° 18′, several fine trees again appear, in the immediate vicinity of the lake. They appear to be not so large, but of more compact and uniform growth. Occasionally, however, a grotesque and misshapen tree may be seen amongst them. Some very fine trees are to be seen at the east end of the lake, as well as at intervals along the Bo-tlet-le river, and by the scanty pools which occur on the elevated riverless plain. These trees average sixty to sixty-five feet in height, some of them spreading their great roots to a distance of thirty feet or more upon the surface of the limestone plain, and looking not unlike ridges of rock themselves. Some very fine trees also occur near the Lua, a tributary of the Zambesi. One of these is shown in an oil-painting by Mr. Baines, in the Kew Museum.

The Baobab is a most useful tree to the natives, for it furnishes them with clothing, food, and medicine. The bark is fibrous, and very strong. In Senegal, it is woven into cloth, and is a constant material for the manufacture of ropes in all parts where the tree grows, not only in Africa, but in India; for it is said to give rise to a common saying in Bengal, "As secure as an elephant bound with a Baobab rope." The method adopted by the natives in Central Africa for obtaining the fibre is somewhat curious. They do not strip the trees at once, or lop off branches for the purpose, as is usually done with other fibrous barks; but when a native wants cord, he makes a cut in the bark about the height of his knee; he then takes the end of the bark, and strips it to about breast-high,

where he cuts it off. When the tree has so grown that this denuded ring is five or six feet above the ground, some one of the next generation repeats the process, and the tree grows up, leaving the scars of these successive injuries. Some trees bear the marks of nine or ten successive strippings, extending half way up the trunk, and forming a series of complete circles or rings around it, frequently projecting so far from the actual level of the trunk as to enable a person to walk round it by holding on to the one above.

The colour of this fibrous bark is mostly of a neutral grey, but a thin outer bark is seen on some trees, of a red or copper colour, which at first is quite smooth, but afterwards splits and curls off, showing the green bark underneath. This splitting of the outer bark gives to the trunk a rough, uncouth appearance. Very strong ropes and nets for catching antelopes are made from the bark.

The fruit of the Baobab is an oblong or oval woody capsule, and hangs from the branches at the end of a long stalk. It frequently measures from twelve to eighteen inches long, and six inches or more across. It is covered with a greenish soft down, and internally it is divided into eight or ten cells. The seeds are numerous, and are imbedded in a pulpy substance, which has a pleasant acid flavour, and when dry is easily pulverized. In Cairo, this is constantly done, and the powder is used for medicinal purposes. In its fresh state the pulp is eaten by the natives, and elephants are said to be exceedingly fond of it. In Central Africa, a regular dish is made from it, by beating it up with water to the consistency of a thin paste, which is eaten by dipping in the forefinger, and then sucking it. In some parts, the juice is expressed from the pulp, and is much valued as a medicine in cases of fever. The woody capsules, after the pulp and seeds have been carefully removed, make excellent vessels for holding water, etc. They are also reduced to ashes, which, along with the ashes of the bark, is boiled in palm oil for use as soap. The leaves, which are palmate, giving rise to the specific name, *digitata*, are occasionally used by the natives for covering their huts; while on the eastern coast of Africa they are carefully dried, and reduced to a powder, which they daily mix with their food, and which has the effect of diminishing the excess of perspiration occasioned by the heat of the climate.

The wood, as we have before said, is exceedingly soft and porous, and it is very liable to the attacks of fungi, and this is said to be particularly the case in Eastern Africa. When so attacked, the wood, of course, soon decays, so that the trunks are very easily hollowed out, and within them the dead bodies of such as are

refused the rite of burial are suspended. They soon become dry, and require no process of embalming. During the progress of the Livingstone expedition, an amusing incident occurred, illustrating the rapidity with which the wood absorbs moisture. In crossing the Lua, a tributary of the Zambesi, one of the party made a large float of thoroughly dry Baobab-wood for the purpose of floating himself across. Before being used it was lighter than cork, but it absorbed the water so quickly, that the unlucky inventor was glad to make all possible haste to shore. It is said that in Abyssinia the wild bees perforate the trunks, lodging the honey in the holes; and this honey is considered the best in the country.

Considering the softness of the wood, it seems surprising how the immense weight of the spreading foliage and heavy woody fruits is supported. Nature, however, appears to have provided bulk of stem to make up for loss of strength; and it is also a remarkable fact, that when the foliage on a particular branch increases so much as to become too heavy for it, the branch itself also increases in thickness. Not, however, equally throughout its circumference, but in a vertical direction, so that the new wood is formed precisely in the position where the greatest strength is required.

The flowers of the Baobab are borne on footstalks four to six inches long. The calyx is very large, and cup-shaped, green on the outside, and covered with short soft hairs. Inside it is of a pale colour, and has a silky appearance. The petals are of a cream white colour, and when the flower is fully expanded, are turned back over the calyx. The stamens are united into a long, thick tube, terminating in numerous filaments, each bearing a one-celled anther of a golden yellow colour. The pistil projects through the stamen tube, hanging down a considerable distance, and terminated by a stigma divided into seven spreading pubescent rays. The tree is deciduous, putting forth its dark green leaves towards the end of our autumn. The flower-buds, however, which in the distance look like small green balls, an inch or more in diameter, begin to open before the young foliage becomes conspicuous, and continues in bloom, while the foliage increases so, that the dark green of the leaves and the cream-white of the flowers offer a pleasant contrast. The appearance of these flowers, when fully expanded, is very beautiful. They frequently measure six inches across. It is no uncommon thing to see the fruits of the past season hanging upon the trees when they are again in flower. Frequently they cannot be got at, owing to the danger of climbing

amongst branches of so soft a wood; or it may be that they are so sheltered by the ramifications of the branches, that the natives are unable to strike them off with the sticks which they throw into the trees for that purpose. The woodcut represents a branch with an old fruit of the past season, a flower-bud, and an expanded flower.

The coloured plate is a reduced copy of a painting, made by Mr. Baines during a boat voyage from Tette to the Kongone mouth of the Zambesi delta, in 1859. From what we have said of the African Baobab, together with the assistance of the plate, we hope that its peculiar form and habits will be understood, and an interest created in its relative in Australia, to which we shall devote our next paper.

IRREGULARITIES OF STRUCTURE IN FISHES.

BY JONATHAN COUCH, F.L.S., C.M.Z.S., ETC.

There is no class of organized creatures that is not liable to some degree of variation in structure from what may be termed its natural type; which may be as regards an excess in the number of the organs, or of their deficiency of development; to which may be added some alteration of shape in the body itself, either as concealed within or prominently on the outside. Variations equivalent to these are common also among vegetables; and this more especially when they have been under the influence of human agency; but in the latter instances we are often able to trace the circumstance to some scarcely obscure cause; and not seldom it has been effected by the skill of the cultivator. But in animals, and even such as are beyond human control, while changes in the normal structure have been of not unfrequent occurrence, and the facts have excited wonder even among the students of nature,—and have even stirred up the spirit of superstition in the seemingly devout, no clue to the influencing cause has been hitherto obtained. The subject therefore remains in doubt, although some of the higher interests of the community are mingled with it; for the human race is not less liable to afflictive and untoward malformations than are the creatures which inhabit the woods and waves, or have been rendered submissive to man's domestic control.

In the human race there are many abnormal variations of structure that when brought to the birth are hidden from sight; and many also are the instances of arrested or unnatural development —perhaps of internal organs—which have been the cause of abortion in an early stage of pregnancy, by fatally interfering with the further growth and development of the embryo. It may be that this is less frequent in animals that are altogether wild, and thus beyond the influence of changing and artificial causes; but that it may occur even among the inhabitants of the ocean will appear from the many instances I shall relate, but in which the irregularity of structure has not been so great as to render the subject of it incapable of obtaining subsistence, and of escaping from the pursuit of enemies, of which the number is greater and the ferocity more intense than among the inhabitants of the land; but that there are many which from deficiency of structure are not capable of successful effort to escape, and perhaps of successfully seeking after food, will appear

from close observation to be highly probable. I have supposed, from extensive inquiry, that in the great family of chondropterygian or what are termed cartilaginous fishes, there is less liability to abnormal formation than in what are termed the bony or malacopterygious kinds; and yet in the former class the common picked dog has been found with two distinct heads, which were joined, at what might be called the neck, to a single body. This little creature could scarcely have lived beyond its birth in the sea; but circumstances forbade the trial of its capacity for a separate existence, and its appearance into light took place on board the fisherman's boat; by which accident this remarkable example of the vagaries of nature was preserved to be gazed at as an object of curiosity.

A very young trout has also been seen, with an effort at the development of a second head; which, however, was much less complete than in the instance of the picked dog. That a somewhat similar formation may be met with in even a higher class of animals, with also a much more extensive condition of development, I have witnessed in the instance of a viper; of which it was the more remarkable that two individuals were met with in the same district, with the interval of only a year or two; and of which the supposition may be hazarded, that both were the progeny of the same parent.

As it is intended that our observations shall for the most part be confined to the inhabitants of the sea, I only remark of this instance of a viper with two heads, that when found it had obtained about the fourth part of the adult growth; but as a viper rarely takes its food in captivity it could not be discerned whether it was with one or both of its mouths that food was taken. The heads were separate to a small distance down the neck, and the one that was on the right was in a small degree the largest. They often moved separately, and at times in different directions. The tongues were thrust out independently of each other; but when a particular object excited attention both of the heads were directed towards it, and they moved forward together.

By the side of these remarkable instances of a double development of the head and neck—in a fish and serpent—I place an instance of the doubling of the vertebra in an opposite direction; which was met with in the mud lamprey (*Ammocœtes branchialis*), of which the following is a description. It had attained to a little more than half the usual size of this fish; and the division of the body into two portions was at about the position of the vent, where both the portions became bent down from the straight direction.

One of these portions was longer than the other, and appeared to be the more active in propelling the undivided anterior part; but the somewhat smaller section lay more in a straight line with the direction of the vertebral column. This shorter portion was also in a small degree irregular in shape; and the separation of the two was such that they did not naturally lie close together; in addition to which the shortest portion was bent down at the caudal extremity. At a little before the place of the separation of these distinct portions of the body, there was a faintly marked first dorsal fin, and a second dorsal was at the exact place of the separation, where it was turned into a circle; so that the appearance was as if this fin had taken its course upward along one of these divisions of the body and down the other. This singular example of abnormal form was capable of much activity.

There are other derangements of the bony framework of fishes which are not less decided than those already mentioned, although less conspicuous in their appearance; and of these the absence of the intermaxillary bones, which implies a shortening of the front of the head, is of not unfrequent occurrence. In the salmon peal (*Salmo eriox*) it has several times been observed; and it has been supposed that in the embryotic young of the salmon (*S. salar*) it is common, although these misformed individuals do not survive to show it in their full growth; but it seems uncertain, if the supposition is to be deemed well founded, whether the greater frequency of this defect is among such as have been bred artificially, or that it has only been more frequently noticed. It appears, however, beyond doubt, that the young of fish bred in confinement or by artificial means are more liable to variation of structure than such as are under more natural influences. This deficiency of the intermaxillary bones has also been observed in several species which have little affinity with each other, as the conger Bass, and pollacks, but in all of them the lower jaw has remained of the ordinary length and structure; nor does it appear that this abnormal defect in the upper jaw and front of the head has proved an hindrance to the powers of these fishes in taking their food, or in securing their safety from injury; since the examples which have been examined were of the ordinary size and in good condition. There are other irregular formations of the bones of the spinal column; of which some have led to great distortion of shape, —as if the back, chiefly in its hindmost portion, were lifted into a hump, with a corresponding change of shape in the fins and lateral line—but there are others which have been attended with so littlo of distortion that the supposition has been hazarded of their being

the marks of distinct species. Mr. Yarrell has recorded an instance of this in the case of the common cod-fish, which had the middle dorsal and first fin short, with the body as deep for its length as the bib—the length of the head compared with the whole length of the fish as one to three. But further, a strong suspicion rests upon what Mr. Yarrell believed to be a species of mugil, and which he has described as the short grey mullet, which, in comparison with the common grey mullet (*M. Capito*), has the length of the head as compared with that of the body and tail as one to three; whereas the proportion of the same parts in the last-named fish is as one to four: the body also deeper, with several other relative differences. I add in this place, with some hesitation, a reference to the fish named the short sea bream, of which a figure and description are given in the "History of the Fishes of the British Islands," vol i., p. 241, and of which not only are the relative proportions different from those of its nearest relative, the common sea bream, but the lateral line and the outline of the edge of the scales are differently shaped. In an example of the trout, the vertebræ behind the vent were so short and pressed together, although their number was normal, that the fish was very short in proportion to its depth.

Some remarkable instances of irregular structure have been observed in the family of Rays (Raidæ); which have led some of the most eminent naturalists into the mistake of supposing that in these examples they had discovered the existence of new species, and even new genera. Our first reference is to what has been called the Cuvier's ray of Lacepede and Fleming, and which is distinguished by the presence of a dorsal fin or elevated membrane at about the middle of the back or disk, in addition to the fins usually situated near the end of the tail. An instance of this formation is mentioned by Dr. Fleming as having been obtained in Scotland; and from the figure of it as given by Lacepede from a dried example, I have no hesitation in expressing the belief, that it was taken from a speeimen of our not uncommon spotted ray (*R. maculata*). It appears that Lacepede was desirous of showing that this existence of a fin on the middle of the disk, had not been produced by the hand of man; but although we readily agree with him in this particular, it appears beyond question that in other instances the knife of the fisherman has been successful in imposing on the judgment of Dr. Fleming, as appears more especially from the "Edinburgh Philosophical Journal" of the year 1841; where we have an account, with a figure, of an example from which this learned naturalist proceeded to constitute a new genus, with the name of *Propterygia hyposticta*, and with

which he associates the still more remarkable figure of a fish described by Dr. Alto as obtained by him in the Firth of Forth. In the "History of the Fishes of the British Islands," already referred to, is represented an example of the common skate, in which the expanded disk, or anterior portion of the pectoral fin, was on one side to some extent separate from the head; but beyond this, it is known that in mere wantonness, when a skate or ray taken in a trawl is too small to insure a price on shore, the mutilation has been inflicted with a knife, and the subject of it again set at liberty.

The extent of injury which this family of fishes will survive, is suprising; and besides the fact that a shark has been active for many hours in the sea after its head has been taken off, instances are known of its having taken a bait in the depth of the sea after its liver had been cut out for the purpose of extracting oil, and also when the whole of the entrails had been removed.

As there will not be occasion in the course of our inquiries, to make a further reference to this last-named family of fishes, I will place here the mention of a case—not indeed of abnormal structure—but of function, in the common skate, and which was discovered when the body of a female was opened. It is known that in the ordinary course of nature the purse or case in which the ovum is contained, is deposited externally, and after a time the young one escapes to light and freedom. But in the instance referred to the purse had been retained within the parent, and there the young, when separate from it, had continued, and grown considerably, to its own destruction; but there was nothing noticed in the young fish or its accompaniments that might explain this irregularity of action.

Among the apparently unnatural phenomena in natural history which appear to be the most beyond our power to explain, is the existence of certain changes of structure in important organs, that might appear to be beyond the power of any influence short of violence to inflict; but which are also in regular succession common to all the individuals that inhabit the district, of which an essential character is that it should be fresh water, whether of a lake or river, with an elevated situation; and when this variation or deficiency of structure exists, the proper form is to be accounted the exception rather than the rule. Such are the instances of which particulars are related in the history of the common trout, in the fourth volume of the "History of the Fishes of the British Islands," and which are here given in one view for greater conveniency, but of which it should be observed that there are other lakes and rivers that appear to exist under the like circumstances without acknowledg-

ing the like changes of structure. On this point my only supposition is that a casual change having been impressed upon the parents when the progenitors were few, the same has been continued in the race by regular succession, through the same law as a similarity of national features, and some forms of disease, are propagated, even in human families, for many generations. "So long since as the times of Giraldus Cambrensis, in the twelfth century, it had been noticed that in the Lyn y Cwn, or Pool of Dogs, in Wales, there was a trout which, I suppose not invariably, was deficient of the left eye; and the same was said of the perch and eel which were found in the same water. Strange as this may appear, we learn from Mr. Hansard's "Trout and Salmon Fishing in Wales," that as regards the trout, the fact has been confirmed by a fisherman of that neighbourhood, as also by the Hon. Daines Barrington." A trout with a remarkable distortion of the spinal column into an arch at the situation of the adipose fin—in this respect resembling what has been already mentioned of the cod-fish—is also reported from the same lake; and Dr. Fleming says that the same occurs in the river Enion in Cardiganshire. I have also obtained it from Caldero in Cumberland, where such fish are common; and in two examples which were sent to me, the head appeared unusually large, the hump or elevation was above or opposite to the anal fin, which had only nine rays; and the adipose fin stood on the top of the arch, the body being bent down again at the tail, the upper rays of this fin longest, nineteen in all, its action in a depressed direction, and the arrangement of bones at its root not as in other trouts; the line of the vertebræ so arched as to cause the distortion. But a more remarkable deficiency or malformation is frequent in a trout that is found in Malham Tarn in Yorkshire, for the knowledge of which I am indebted to the kindness of W. Morrison, Esq., M.P. The situation of this tarn is on a hill, twelve hundred and fifty feet above the level of the sea; the rock near is limestone, and the water is clear. The fish are termed silver trouts from the brilliancy of their appearance; but there is another species in the same water, which I have no doubt of being the lake trout—*Salmo ferox*—of which the colour bears a strong impression of yellow. This silver trout reaches the ordinary size of its species and is in good condition; but the deficiency consists in the entire absence of the posterior plate of the gill-cover, sometimes on one side, at others on the opposite, and in an example sent to me this deficiency was on both sides, so that in every instance the fibres of the true gills were bare and open to the water. About one in four or five of the trouts caught in this place are found

to be marked with this deformity; notwithstanding which, the specimens examined bore no evidence of having been subject to any inconvenience from this defect. Besides the casual malformation of a trout caught in Cornwall, already mentioned, where there was a second and smaller head that appeared projecting from the more natural part, Mr. Yarrell mentions one in which there was both a separate head and tail. Deformed trout, of which some are like those already mentioned, are also referred to by William Thompson in his "Natural History of Ireland;" so that as far as observation has extended, no fish appears so liable to irregularities of structure as the trout; and of these, deformities in the vertebral column are especially frequent and conspicuous. In the distinction of nearly allied species of this and other fishes, much dependence has been placed on the number of the vertebræ; and yet on close examination it has been ascertained that in many instances where the species is beyond doubt, the number of these bones has varied, of which the herring is an example, as is also the trout, where the number has been counted from fifty-seven to sixty; and in such cases the number of the fin rays is much subject to diversity. Dr. Gunther in his "Catalogue of the Fishes in the British Museum" (vol. vi.), says of his *Salmo nigripinnis* that a deformed example has been described and figured as the "hog-backed trout" of Plinlimmon; and a similarly deformed specimen has been examined by Dr. Cobbold. Instances have been recorded of the same fish with an undulation in the vertebral column, and a couple of examples where this arrangement of the bones had taken the shape of the letter S. A shortening or distortion of the bony structure of the body must indeed necessarily produce some irregularity in the formation of the fins; but instances are not unfrequent where the fins alone have shown deficiency or exuberance, and in the larger number of instances it is the former. For it is only in the gold-fish—a species that has been long under unnatural influences—that I have met with a positive multiplication of these organs; and it has been only then in reference to the lobes of the caudal fin, the lower portion of which has been separated into two. In one instance a pilchard was destitute of a dorsal fin, without any mark of violence; and in another instance the tail was spread into at least twice the usual dimensions. A conger has been found destitute of a dorsal fin along the back until close to the extreme end of the tail; and I am informed of another in which the anterior end of this fin was turned or twined circularly on itself, somewhat after the manner in which a ribbon is folded up. The blunted end of the tail of this fish, which is of frequent occurrence, may have been

caused by the bite of an enemy, although there has appeared little mark of such violence; but although in such instances a portion of the spine has been deficient, the dorsal and anal fins have become united so as to have little appearance of a defective nature in the caudal structure. In reference to the dorsal fin again, in the hake's dame, or greater fork-beard (*Phycis furcatus*), its elevated and pointed shape is judged to constitute the sufficient distinction from a species known in the Mediterranean (*Phycis Mediterraneus*); but from accident, as seems probable, or want of development, the elevated rays are often deficient, so that only one of them, which may be the first, second, or third, shall project beyond a rather low border, thus tending to throw a doubt on the pricipal mark of distinction between it and a species not yet known as British.

Among the Pleuronectidæ or flat-fishes, it is not uncommon for the flounder, among others, to be equally coloured on both sides, in which case also there is often a defect of outline along the dorsal ridge, by which the head seems less united to the body. A change of aspect is also not uncommon in some species of this family, in which the head is directed, perhaps to the left, when the ordinary direction is the reverse. The topknot (*Rhombus punctatus*), has also been known to have its upper or rough side destitute to a considerable extent of scales and colour, as if a thin skin had taken the place of the usual integument; and more remarkably still, in one instance, the tail was in a rudimentary state so as to have been of little service for motion.

The absence of a fin, or a defect in its structure is scarcely uncommon in other instances; as in the tub-fish (*Trigla hirundo*), where one of the pectorals has been much longer than the other; and in the shanny (*Blennius pholis*), there has been a congenital absence of the pectoral on one side; a deficiency imperfectly compensated by an additional ray to the two in the ventral fin below it. A cod-fish has also been met with, that never had possessed more than one pectoral fin; but a more important defect in an example of this species was the absence of both eyes; and that they had never existed was apparent from the structure of the parts. Yet so effectually had the other organs of sensation supplied the deficiency, that this fish was of full growth and in a well fed condition.

A variation in the internal structure of fishes has been less frequently noticed, but when observed has not been less remarkable. In a cod-fish these organs had suffered such an arrested development, as to deprive it of the faculty of procreation. A salmon has been met with, in which was only a single lobe of roe,

which is normally the case with the atherine (*Atherinea presbyter*); and such was the case also with the milt in all the examples of the samlet (*Salmo salmulus*) that were obtained in the month of December. A case of hermophroditism has been examined in the mackerel, where a small and imperfectly developed milt lay between two lobes of roe. But a still more remarkable structure was examined in the gar-fish, where at first view thére appeared to be two pair of fully enlarged lobes of roe; and on closer examination there was found on the right side of the fish a loosely lying lobe, which was directed forward, with its hindmost portion fastened to the side of the body at some distance anterior to the ventral fin, and having no connection with the other lobes, except in lying side by side close to the lobe opposite to it. The lobe here referred to might be said to begin or end, at the vent, and a little posterior to the ventral fins it became contracted, as if tied with a light string; at which place it became united to another lobe, which stretched forward almost to the end of the first mentioned lobe, where the end of the latter appeared as if bent round it. Again, at the vent, in contact with the other that appeared to begin at that place, was a lobe that passed forward without reaching so far as the one already mentioned as being contracted, or tied as with a string. The appearance thus presented was as if there were four distinct lobes each one of which was full of roe; but the first I have mentioned, and which extended further forward than the others, appeared to have been united to the entrail, where the latter was fastened to the side of the body; but as this entràil, had been removed this fact could not be clearly ascertained. The other long, but seemingly double lobe had its orifice at the vent, as had also the short lobe near it; but it is possible that the anterior portion might be able to deliver its grains into the hindmost portion or lobe; and the grains of all had the appearance of being fertile.

On the foregoing subject I add, that in an examination of that prolific species of shark, the picked dog, there has been found two distinct yolks in one ovum, as is sometimes found also in the egg of the domestic fowl; and again, two embryotic young ones have been attached to a single ovum by one cord of connection; which became divided into two branches not far from the point of insertion into their bodies. It is probable from their being thus joined together, that soon after their birth the fate of these united brothers would have been decided, without the prospect of escape.

POPULAR DELUSIONS ON TECHNICAL EDUCATION.

It will only be by a great effort that the average families of the middle class in this country will be induced to become cultivators of science. Amongst the aristocracy, science has a very few distinguished students, but no branch of it can be said to be fashionable, and whenever subjects that require a knowledge of physics, chemistry, or physiology, come before either House of Parliament, a very deplorable amount of ignorance is sure to be displayed. It is, moreover, very rare to find a Cabinet Minister possessed of even elementary education in such a direction, and members of the military and naval professions, who have abundant opportunities for making valuable observations, do not find any official encouragement for such an application of their leisure time. The late Prince Consort endeavoured to raise the tone of education amongst the upper classes, but since his death they have shown little inclination to follow his example. If we look to rich, mercantile, and trading families, we find as a rule that physical sciences are not in much favour. If one of the sons is destined for the medical profession, he first receives an ordinary classical education, and then, with the help of professional "crammers," makes his way as fast as possible through the routine of subjects on which he has to suffer examination. Hence, although it would be easy to make out an honourable list of surgeons and physicians who rank amongst original observers and discoverers, the average "doctor" can scarcely be pronounced a scientific personage, and it is not uncommon to find men in considerable practice who make the most absurd mistakes if they try to talk upon a scientific subject. Another son may be intended for the church, and he is not troubled with science, because neither his parents, his tutors, nor the public have yet arrived at the idea that some accurate knowledge of the works of the Creator is necessary in a profession supposed more than others to be dedicated to his service. A third son may be brought up as a merchant, and a fourth sent to the bar, but like their brothers they will learn no science unless strong personal predilections incline them to its pursuit.

We have recently heard of Oxford and Cambridge M.A.'s perfectly bewildered with a simple astronomical telescope, and nothing is more common than for dealers in philosophical instruments to have them returned with most astounding complaints, arising entirely out of profound ignorance of elementary laws. In one case

that came under our notice, a well-to-do gentleman thought himself aggrieved because a barometer, when carried to a particular place outside his house, did not stand at the exact height at which another barometer, used on another occasion, did stand, as mentioned in a book.

There are throughout the country Field Naturalists' Clubs, and similar institutions which do much to further natural history pursuits, and we have a considerable body of astronomical observers scattered in various directions. Still few take the pains to do anything that is difficult, or to acquire information that demands study or thought; out of a hundred persons who like to join a pleasant excursion, and bring home plants, or bottlesfull of aquatic curiosities, can it be said that five take the pains to learn anything of vegetable physiology, to understand the principles on which botanical classification is based, or to do more than look at the appearance, and pick up from some one else the name of an insect or an infusorian?

It is not with a view of depreciating the attainments of our countrymen that we write these remarks, but for the sake of showing the sort of stem on which efforts are being made to graft technical education, and in the hope of giving timely warning of errors into which the public seem likely to fall.

The prevailing want of scientific knowledge leads to false conceptions of what should be done, now that "technical education" is demanded as an indispensable aid to national prosperity and wealth. There is a notion abroad that professors of science are to teach those portions of their several subjects which can be warranted to pay. "Practical men," that is, persons who act by what is vulgarly known as "rule of thumb," do not want their sons to be taught "theories"—they demand on their behalf what they call "facts." To the chemist they say, what do we care about your theories of composition, your atoms, molecules, laws of substitution, compound radicles, organic bases, and so forth. We want our boys to grow up with the ability to print cotton, smelt iron, or tan skins. They fancy the botanist can tell their offspring how to find new gum trees, or discover fresh dye-stuffs, and so forth, without elaborate inquiries into the organs of fructification, and the relative disposition of parts. Students of medicine coming from unscientific families are often much annoyed and puzzled if a well-informed lecturer brings before them any of the doubts and uncertainties that remain to be cleared up about the structure of organs or their functions. They want positive information. They wish disease to be made as

plain and palpable as a letter-box, and the cure by the administration of a bolus to be as simple as the insertion of an epistle into its appropriate slit.

Persons brought up in what may be fairly called the unscientific atmosphere of common-place English life, have immense difficulties to contend with when they start on a scientific career. Their habitual modes of thought have created an inaptitude for scientific methods, and amongst their relatives or friends, perhaps not one has a particle of sympathy for any of those intellectual pursuits. In London, and very large towns, there are scientific groups to which access is easily obtained, but in smaller towns and rural districts an astronomer, a botanist, or a microscopist often finds himself alone. Scores of letters have reached us with complaints of this description, and we could point to many individuals who under a more rational state of society, would be local centres of scientific intelligence, but who now work like hermits, because the world around them is an intellectual desert, from which they can rarely escape.

A sudden demand for "technical education," without a previous or accompanying one for a general education leading up to it, is much like an application to have a house roofed and its chimney-pots fitted before the foundation is laid, or the walls are reared. The application of scientific principles to any special calling must necessarily and logically come after those principles have been fairly learnt, and it would be impossible to devise courses of study for chemistry, or geology, or physics, that were particularly adapted to cotton-spinners, or iron-founders, and not as useful for other sorts of men. After the general principles and the leading facts of a science have been mastered, its special applications may fairly begin; but special schools should be subsidiary to general schools, and cannot possibly be substituted for them.

If society determined that in a given number of years it would rear up, say a thousand good scientific dyers or smelters, the most certain way to success would be to give a very much larger number of persons a good elementary education in science, and select the most fitting for the more special culture. It would be a waste of time for those who have no taste or inclination towards the sciences to be forced into their prolonged study. To know a little of such matters should be considered, like writing or elementary arithmetic, an essential part of the education of all, and the requisite means should be provided for all. More advanced teaching should be abundantly and cheaply provided for those who desire it; but

no attempt should be made to drive unwilling students through such a course.

In early life tastes are frequently formed which determine the whole current of future endeavour; but some fact or incident is necessary to make the child aware of its natural tendencies. Simple explanations of common phenomena, or the example furnished by seeing others take an interest in particular subjects, may occasion the germination of powers that would have laid dormant without them. If we consider the small proportion of families in the well-to-do classes in which children are likely to have such advantages in reference to the sciences, we may readily believe that only a very small proportion of the scientific capacities of the country can possibly be brought out until a considerable change in the influences which surround childhood and youth have taken place.

Science for all would soon lead to remarkable proficiency on the part of a naturally selected few, while the attempt to deal with great branches of mental culture as if they were simply part of the plant or utensils of a manufacturing business will lead to no satisfactory result. Technical processes can rarely be thoroughly understood by professional teachers. The practical dyer, or spinner, or smelter, finds his commercial success dependent upon details which no lecturer could teach; and if it were possible for school or college instruction to be really successful in making pupils understand how processes were conducted at a particular moment, the very next day fresh processes might be introduced that would render the information of little avail. Of course, if the public demand "technical education" as a substitute for a real education, they will find plenty of quacks ready to supply it for a consideration. There are folks quite ready to keep an emporium of technical education, just as others open a general shop. Chemistry for dyers, botany for perfumers, electricity for telegraph-men, and mechanics for engineers, will be put up and sold like candles and blacking, red herrings and cheese. The Government will, of course, be appealed to by scientific bagsmen touting their wares, and the shade of the Prince Consort invoked to cover any impudent job that may be supposed to need a screen.

Parallel with sham science will run the course of sham art—drawing for the crockery trade, colouring for floor-cloth manufacturers, or perspective for paper-hangers, will be put forth in glaring prospectuses, and proficient pupils will be promised a certificate or a prize. No honourable man who knows anything about science would mix himself with such quackery. A real chemist knows that

there is only one science, which he is named after; and that he cannot subdivide it according to the trade of his pupils' parents, or the kind of calling by which they are expected to grow rich. He has not one chemistry for doctors, and another for glass-blowers; nor does he know any way of teaching except by exhibiting and arranging facts so as to make them illustrate principles and expound laws. The abstruser departments of his science, so far from being the least fitted for those who are about to enter manufacturing industry, are the most essential to any one who is desirous of discovering new products, or improved methods of working those which are already known. Those who have followed the admirable papers of Mr. Barff in our pages will be able to appreciate this fact, and it could not for a moment be doubted by any real proficient in the science. The doctrine of substitution, for example, belongs to a difficult portion of chemical theory. It explains how, in a series of complex substances, certain elements, or certain compounds capable of behaving like elements, may take each other's places. The entire set of compounds so obtained belong to one class or series, and they have certain properties in common; but the substitution of one element for another may make exactly enough difference to serve some important purposes in practical life. A department of chemistry which enters importantly into industrial pursuits is that of synthesis—the artificial formation of compounds exactly resembling, or analogous to, the productions of Nature in the animal kingdom, or in the organic world. Suppose, for example, a chemist were asked to make quinine in his laboratory, instead of obtaining it in a roundabout process, by inducing somebody to grow trees in India from plants collected in America—getting their bark sent to England, and then operating upon it in various ways. The problem would be a hopeless one in the hands of a student who had merely learnt the stuff called "technical chemistry;" but very likely to succeed through the labours of another who had clear ideas of the theory of the science, and who knew how similar productions are formed by Nature herself.

The most successful advances in manufacturing chemistry will be made by those who, having the best understanding of the theoretical composition of bodies, are best able to perceive in how many ways they may be taken to pieces, and what groups of new combinations the several portions may be able to form.

Chemistry affords some of the clearest arguments to show the folly of a "technical" in contradistinction to a real theoretical and scientific education. Theories of science are not mere hypothesis or

supposition. They may not always be right, and they should always be held subject to correction or further elucidation. Their value lies in their quality of co-ordinating facts that belong to the same category, in their enabling reason to be exercised in the consideration of phenomena, and in their indicating the means by which it is possible a control over nature may be obtained. A statement of a law is a shorthand epitome of a group of facts. It matters not how large the group may be, the formula in which the law is stated comprehends them all. Without theories all sciences would be resolved into their primitive elements; they would consist merely of huge heaps of facts which no memory could recollect. A science treated without theory is worse than even the Chinese language with its thousands of characters; the theory comes like a phonetic alphabet, and enables a few symbols to express the whole.

The sciences and the fine arts, as instruments of training and development, deserve a recognition very different from that which the cant and quackery of "technical education" contemplates. Learn science from a love of truth, and for the pleasure as well as for the duty of exercising our faculties upon the phenomena around us. Study art because the perception of the beautiful elevates and adorns our lives. In thus obeying natural laws of mental development, mercantile profit will come in its due place.

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

(*With a Coloured Plate.*)

CHAPTER IV.

THE ANGLO-SAXON WOMEN.

We have no authentic history of what took place in our island during the period between the time when the Roman government was withdrawn from it, and that in which the Anglo-Saxon power became established in Britain; that is, during the first half of the fifth century. The towns seem to have lived in separate independence. Their populations, as I have remarked before, appear to have been recruited in later times chiefly from Teutonic blood; but they had adopted Roman manners, had embraced the Roman civilization, no doubt with most of its vices as well as its virtues, and spoke the Latin language. They were, in fact, looked upon by the invaders as Romans and as enemies, and, as the Teutons were themselves unacquainted with the advantages of living in towns, when these fell under their power they were plundered and destroyed. But the townsmen were protected by strong walls, and knew how to defend them; and the Anglo-Saxon chieftains, as they assumed regal power, soon saw the advantage of compounding with and conciliating the towns, and securing to themselves a revenue by taking a tax just as the townsmen had before paid their tax to the imperial government. Thus there came into existence throughout the country two forms of society, the patriarchal clanship, if we may so call it, of the Teutonic peoples, in alliance with the Roman civilization of the towns. In their slow, imperfect amalgamation, the former gave the force, the latter the polish, to the whole. The Saxon freemen who had conquered the land shared it among them in lots, and each thus became a landholder and the head of a family. In this manner the inhabitants of the towns formed so many little governments republican in character, while the broad lands outside were in the possession of a strong aristocracy, which acknowledged a superior chieftain who claimed the title of king. Thus arose that distinction, we might almost say antagonism, in character and spirit between town and country which has continued, more or less, down to the present time.

When the Anglo-Saxons settled in our island, the patriarchal spirit existed among them in its full force. The father was absolute master in his own family, and could dispose of his children at his will. He sold his daughters into wedlock, and he not unfrequently sold his sons into slavery. An Anglo-Saxon poem of Gnomic Verses, preserved among the contents of the well-known Exeter Book, tells us somewhat quaintly that "a maid is the delight of the eyes" (mægð egsan wyn), and that "a lover requires a physician" (lefmon læces behofað); but the idea intended to be conveyed in the latter saying is not very clear. It is certain that the maiden was entirely in her father's power, and absolutely at his disposal, and that she had no will or choice of her own. In fact, at the time when St. Augustine brought Christianity among our Anglo-Saxon forefathers, maid or wife was regarded absolutely as an article of property, in the one case of her father, in the other of her husband; and the laws of Ethelbert, our first Christian Anglo-Saxon king, contain distinct provisions to meet the crime of stealing them. The words of the first are, "If a man carry off a maid by force, let him pay fifty shillings to her owner, and afterwards buy her from him;" the terms of the other law are, "If a man carry off a freeman's wife, let him procure him another with his own money, and deliver her to him." It appears that the former was the primitive method of procuring a wife; the lover, who certainly ran the risk in this state of things of being in want of a physician, after he had fixed his eye upon a maiden to his taste belonging to some other family than his own, and, perhaps with her secret consent, went with some of his friends and carried her off. This was the form of proceeding of a man who prided himself on his bravery. The girl's relatives took up the feud and pursued him, and the quarrel was only appeased by the lover paying the value fixed upon her by her father, and so retaining possession. My friend Mr. Thrupp, in his excellent and interesting volume, "The Anglo-Saxon Home," has traced the progress of the transition from this rather lawless practice of stealing first and paying the price afterwards, to the more legal and reasonable proceeding of buying in the first place for a stipulated price.

The price of a maiden was generally fixed at so many head of cattle. A passage in the Gnomic Verses of the Exeter Book, which I have already referred to, shows us how universally this practice of buying the wife prevailed. It is as follows:—

Cyning sceal mid ceape cwene gebicgan;	A king shall with cattle buy a queen;

bunum and beagum	with cups and bracelets
bu sceolon ærest	both shall at first
geofum gód wesan.	in gifts be bounteous.

Thorpe's edit. of the "Codex Exoniensis," p. 338.

At a later period, when the peoples began to enter more extensively into diplomatic relations with other countries, the king gave away his daughters for political purposes; but their own feelings were never consulted. So, after the introduction of Christianity and monasticism, the father dedicated his daughter to a monastic life, if he willed it, long before she was capable of forming a judgment for herself. In the middle of the seventh century, when Oswy, king of the Northumbrians, had defeated and slain Penda, the pagan king of the Mercians, he gave his daughter to Christ, who thus, according to the views of the church, became her spiritual husband, and consecrated her to Him in perpetual virginity. Bede, who was nearly a contemporary, tells us that the princess was at that time scarcely a year old. The clergy laboured to weaken and break down the power of the father or husband, and especially the former, over the daughter or wife, and they were in the end successful. The change was going on gradually for three or four centuries, and it was not till after the middle of the tenth century that woman obtained the right of insisting upon her own objection to any husband proposed to her by her father, and thus became her own mistress. It may be remarked, that the memory of the old principle of the father's right over his daughter is still preserved in the marriage ceremony, in our modern form of a father giving the bride.

The primitive marriage ceremony among our forefathers was very simple, consisting, in fact, of a bargain and a sale; its principal form was hand-fasting (hand-fæstnung), or pledging each other's hand. The contracting parties took each other by the hand, proclaimed themselves man and wife, and made certain promises of love and affection on the part of the bride, and of good treatment and protection on that of the husband. The lady's friends were present, and her father or guardian received the purchase-money, which had been agreed upon, and delivered her to the bridegroom. In a bargain like this, it is evident that a good amount of deception might be practised on the part of the father in misrepresenting his daughter's qualities or attractions, and this was evidently not uncommonly the case, for one of our earliest codes of Anglo-Saxon laws, that of Ethelbert, Augustine's convert, contains a provision against it. It was, no doubt, a very early law of the Anglo-Saxon people, for, though written in the code of laws as prose, it seems

by its rhythm and the natural division of the lines, to have been originally composed in alliterative verse, to be more easily carried in memory by the primitive dispensers of justice, and I will therefore give it here, arranged in verse, as a singular monument of primeval manners :—

Gif man mægð gebigeð	If a man buy a maiden
ceapi, geceapod sy,	with cattle, let the bargain stand,
gif hit unfacne is;	if it be without guile;
gif hit þonne facne is,	but if there be deceit,
ef[t] þær æt ham gebrenge,	let him bring her home again,
and him man his scæt afere.	and let man give him back his money.

"Ancient Laws and Institutes of England," vol. i. p. 22.

We have no direct information as to the limit of time after marriage, in the earlier ages, within which the husband was required to send back his wife to her father if dissatisfied with her. In course of time the father sought to conceal the mercantile character of this transaction, by representing it as a compensation for the expense for the young lady's feeding and education; and the money paid was then called a *foster-lean*, or payment for nourishing.

The custom of espousals also prevailed among the Anglo-Saxons at an early period, that is, the father entered into an engagement for the future marriage of his daughter at any period before she had reached a marriageable age. After the introduction of Christianity, the clergy gradually reduced this engagement to a regular and stable system, by applying to it the Roman law of espousals; and the lover was required to give at that time a *wed*, or security, for the due performance of his part of the contract. Hence the ceremony of marriage has been called in English, down to the present time, a *wedding*.

At first the foster-lean was expected to be paid at the time of the espousals, which was a sort of selling beforehand, and led to other abuses. By the law of espousals, by which the ecclesiastics sought to establish more and more their influence over the female sex by emancipating them from the paternal power, the contracted bride, up to a certain age, had the right of refusing to perform the contract; if she did this at ten years of age, the contract was void, and neither father nor daughter were liable to any punishment; if she did it at any time between her tenth and twelfth years, the father was liable to a fine; after that age, both were punishable. It is evident how this law might be abused by the father of an attractive daughter, who might espouse her and obtain the foster-lean, and then espouse

her to a second lover, and obtain a second payment, and so on to the third, and all this without parting with the girl, yet retaining the money. It will be seen that in these primitive times, lovers were liable to be imposed upon in more ways than one. And we may be sure that this last-mentioned mode of deception was not of very unfrequent occurrence, for, though not provided against in the secular laws (for the practice of such matrimonial pre-contracts was an ecclesiastical institution), yet it was condemned in the laws of the church, and in the Pœnitentiale of Theodore of Canterbury, and the Confessionale and Pœnitentiale of Ecgbert of York, there are severe enactments against it. The latter orders that if any woman be espoused (*beweddod*) to a man, and another take her from him, she shall be excommunicated; and in the two former codes it is ordered that "it is not permitted to her parents to give a girl, who is espoused to another man, unless she declare that she is altogether resolute not to have him."* This ecclesiastical law appears not to have been popular among the people, and instead of allowing the espoused girl, when she refused the first husband provided for her, to be given to another, Theodore and Egbert's ecclesiastical law ordered her to retire to a convent. Still this proved unsatisfactory, and it was finally arranged that the foster-lean should be paid, not at the espousals, but on the completion of the marriage.

The clergy had laboured to introduce more formalities into the ceremonial of marriage, and to add to it more that was typical and figurative. At the espousals, after the taking of hands, the couple who were thus engaged, made an exchange of presents. Among those given by the bridegroom was a ring, which was placed on the maiden's right hand, and which was to be worn so until the time of her marriage. They also exchanged a solemn kiss, which was looked upon as having a spiritual meaning. At the marriage, if espousals had previously taken place (for they were not *necessary*), the ring was removed by the bridegroom to the bride's left hand, and was placed on the first finger—if there had been no espousals, he then gave it her, and placed it on the first finger of the left hand. The father then transferred to the husband his authority over his daughter, which was called in Anglo-Saxon the *mund* (from *mundian*, to protect), but for this also he required payment. This transfer was made by another typical gift; the father delivered the bride's shoe to the bridegroom, and the latter touched her on the head with

* "Puellam desponsatam non licet parentibus suis dare alteri viro, nisi illa omnino declarat se eum nolle; tunc, si velit, licebit ei id derelinquere, et vitam monasticam sibi eligere, si velit."—"Confess. Ecgberti," 20. Compare "Theodori Liber Pœnitent.," vi. 29.

it, whereby he was considered to assume the marital authority. This early ceremony, too, is still preserved in memory in the popular custom of throwing a shoe after the newly-married couple when they are starting on their wedding excursion.* After these mere ceremonies were over, came the more substantial considerations on both sides, which had been arranged beforehand, but which had now to be completed. Among these, the most remarkable was the gift made to the wife by the husband the morning after the marriage, and called from this circumstance the *morgen-gifu*, or morning-gift. It was originally a mere voluntary gift, made on the morning after the wedding, to testify the degree of satisfaction of the husband with his wife, and depended upon his natural generosity and upon his approval of her. Afterwards it was considered as one of the most indispensable articles of the marriage-contract, and the amount was stipulated before the ceremony, partly because it was an acknowledgment that the husband was satisfied, and, after he had given the morning-gift, he had no longer the right of returning his bride. It was at first a comparatively trivial present, but it afterwards became, among wealthy families, a large amount of property, and sometimes consisted of considerable estates, which were the absolute property of the wife, and she had the full power of disposing of it if she became a widow. Thus, at the close of the tenth century, the Lady Wynflæd, by her will, leaves to one of her relatives the estate at Faccancumb, which had been given to her as her morning-gift; and, near the same date, Elfhelm makes an entry in his will, "And I make known what I gave my wife for a morning-gift; that is Baddow, and Burstead, and Stratford, and the three hides at Heanhall; and I gave to her, when we first came together, the two hides at Wilbraham, and at Rayne, and what is thereto adjacent."† The practice of the morning-gift was established throughout the Teutonic race. When King Athelstan's sister, Eadgith, was married to Otho, Emperor of Germany, her imperial bridegroom gave her for her morning-gift the city of Magdeburg.

* It has been supposed that this custom of the gift of the shoe had its origin in that of placing the foot on the neck of prisoner or slave, and that it was typical of the state of subjection in which the bride was placed towards her husband. When the married pair retired to rest, it seems that the shoe was placed at the head of the bed on the husband's side; and that, by way of practical joke, when the lady was accused of being rather tyrannical in temper, some facetious individual sometimes stole into the room, and slyly transferred the shoe to the wife's side. See Mr. Thrupp's "Anglo-Saxon Home," already referred to, for a longer and more detailed account of the customs and ceremonies of the Anglo-Saxon marriages than I can give here.

† See the original wills in Thorpe's "Diplomatarium Anglicum Ævi Saxonici," pp. 583 and 596.

In all these stipulations of inferiority and subjection of the wife to the husband, there was far more of theory than of practice. The natural influence of Womankind soon overruled and suppressed them, at least practically, which was of greatest importance. If she was bound to an apparent subservience, he was bound to cherish and protect her; and he had, as far as his means went, to endow her with property. The position of the wife, and indeed of woman generally, went on improving during the whole Anglo-Saxon period. By the time of Cnut, it had become usual, if not compulsory on a man of any property, to make at his marriage a substantial settlement upon his wife, and she had a legal right, upon his death, to a certain portion of his wealth. But, if the widow married within a year after the death of her husband, she forfeited everything she had received from him. This is, no doubt, the origin of our feeling that a widow ought to remain a year after her husband's death before marrying again. Singularly enough, the Danes, who are usually looked upon as mere sanguinary savages, appear to have been instrumental in finally raising the position of Womankind in England, and the sex appears as enjoying most consideration and protection, legally at least, in the laws of King Cnut. One of woman's domestic privileges among the Northmen was curious enough; she had a right to the custody of her husband's keys, and, if he refused, she had a remedy at law, by which she could compel him to give them up to her. Cnut introduced this provision into the Anglo-Saxon laws, and he did so with the object of abolishing a part of the older Anglo-Saxon law, which was very cruel towards the wife and family. By the earlier laws, if a husband commited theft, his wife and all his family, even the child in the cradle, as well as himself, were liable to be sold into slavery, and this continued to be the case for a long period, until Cnut abolished it. He enacted that in regard to the object stolen, "unless it has been brought under his wife's key-lockers (*cæg-locan*), let her be clear; for it is her duty to keep the keys of them, namely, her "hord-ern," and her chest, and her 'tege.' If it be brought under either of these, then she is guilty."* These three depositories are to be explained as her store-room, her chest, and her cupboard, and they are apparently those parts of the house only which were locked.

The interior of the house, indeed, was the wife's special province, and, as with the Roman lady whose epitaph has been given in a former chapter (STUDENT, No. II., p. 92), one of her most estimable virtues was being "a keeper at home." In the poem

* "Ancient Laws and Institutes of England," vol. i., p. 419.

of Gnomic Verses, quoted before from the Exeter Book, we are told:—

Fæmne æt hyre bordan geriseð;	A damsel it beseems to be at her table;
wid-gongel wif word gespringeð,	a rambling woman scatters words,
oft hy mon wommum bilihð,	she is often charged with faults,
hæleð hy hospe mænað,	a man thinks of her with contempt,
oft hyre hleor abreoteð.	oft smites her cheek.

Thorpe's "Codex Exon.," p. 337.

The females of the Anglo-Saxon household were not idle in their bower, but, as with the Franks also, worked industriously, both in producing the materials of the dresses, and other objects used by their husbands and themselves, and in making them. We have from time to time, in early writers, allusions to this domestic industry. In the Pœnitential of Theodore of Canterbury, which dates from soon after the middle of the seventh century, women are forbidden to employ themselves on Sunday, either in weaving or in cleaning the vestments, or in sewing them, or in carding wool, or in beating flax, or in washing garments, or in shearing the sheep, or in any such occupations.* Here we see, at that early period, the whole process of the construction of clothing entirely in the hands of the women of the household. Boniface, in one of his letters (Epist. 20), tells of a damsel who was grinding in a mill, and who saw lying near her another woman's new spindle, which was ornamented with carving (*novam colum sculptura variatam*), which seemed to her so beautiful that she stole it. The distaff was so generally the distinguishing implement of the lady of the family, that the word distaff, or spindle, was used for her in distinction from the spear, as distinctive of the man. King Alfred, in his will, made soon after the year 880, says, in his directions for the distribution of his property, that his grandfather had bequeathed his lands "to the spear-side (on þa spere-healfe) and not on the spindle-side (on þa spinl-healfe), and that, therefore, he wished it to go by preference to his male descendants.† These occupations were considered equally fitting to queens and princesses as to ladies of ordinary rank. William of Malmesbury

* "Item feminæ opera textilia non faciant, nec abluant vestimenta, nec consuant; nec lanam carpere, nec linum batere, nec vestimenta lavare, nec verveces tondere, nec aliquid hujusmodi habeant licitum." Theodor. "Pœnitent." p. 45, in the "Ancient Laws and Institutes," vol. ii.

† See Alfred's will in Thorpe's "Diplomatarium," p. 491.

tells us that the daughters of King Edward, Alfred's son and successor, employed themselves from their childhood in the labours of the distaff and the needle. Long before this, in the seventh century, Aldhelm, who wrote especially for the ladies, had made the distaff (*fusum*) the playful subject of one of his riddles. Before the Norman period, the English ladies had become celebrated even on the Continent, for their skill in spinning, weaving, and embroidering; and one of the Norman writers on the history of the Norman conquest of England, whose name is not known, tells us how the French and Normans admired the beautiful dresses of the English nobility, and adds that the English women "excell all others in needlework, and in the art of embroidering with gold."* Another Norman writer of the same period, William of Poitiers, assures us that the Anglo-Saxon ladies were so celebrated for their superior skill in embroidery, that the finest productions of the needle were called by way of distinction "English work" (*Anglicum opus*).†

With such skill in working the materials, we are not surprised at hearing the old writers more than hinting at the love of the Anglo-Saxon women for dress and ornament. Thus Aldhelm, in the latter part of the seventh century, comparing the women of the cloister with the women of the world, describes the latter as yearning to adorn their necks with necklaces, and their arms with bracelets, and to be decked with rings on their fingers, set with gems. . . . They sought to arrange delicately their waving locks, curled artificially by the curling-iron, with their cheeks died red with stibium.‡ And in another part of the same book, his treatise of the Praises of Virginity, he complains of their changing the natural colour of the fleeces, for woollen was very extensively used in their garments, in order to dye them red, and purple, and various other colours, looking forward to the time when all this vanity will come to an end, and when the wool will cease learning to counterfeit other colours than its own.

Nec varios discet mentiri lana colores.§

We might suppose from the words of Aldhelm that the material used for the dress in his time was chiefly woollen, but we know that linen was also in general use; and at this time silk (*seolc*), and other valuable materials of foreign manufacture, had been introduced.

* "Anonymi Gesta Gulielmi ducis, ap. Duchen.," p. 211.

† Gulielmi Pictavens., "Hist.," ib. 211.

‡ "Ista tortis cincinnorum crinibus calamistro crispantibus delicate componi et rubro coloris stibio genas ac mandibulas suatim fucare satagit." "Aldhelm, de Laudibus Virginitatis," p. 17, ed. Giles.

§ "Aldhelm, de Laud. Virg.," p. 75.

It is to be lamented that the Anglo-Saxon writers who have left us their protest against the richness of the materials, the variety of colours, and the love of jewellery displayed by the Anglo-Saxon ladies, have given us no description of their dress, or of the different articles of which it consisted; and it is only at a comparatively late date that the Anglo-Saxon artists enable us, by the illuminations in their manuscripts, to form a notion of its outward appearance. We have every reason, however, to believe that the Anglo-Saxon costume, which seems to have resembled pretty closely that of the Frank, hardly underwent any change through several centuries, except so far as regarded its richness of material and ornamenta-

THREE OF THE VIRTUES IN ANGLO-SAXON COSTUME.

tion. A few groups from the illuminations just mentioned will convey to our readers the best idea of this costume, and of the general appearance of Womankind among our forefathers at this remote period. Our first cut is taken from a manuscript of the Psychomachia of Prudentius, which is, perhaps, of the latter part of the tenth century (MS. Cotton. Cleopatra, C. VIII. fol. 4, v°.). The original represents the lady Wisdom addressing the Virtues, three of whom are here given as good examples, not only of the costume, but of the gesture, and action, and characteristic appearance of Anglo-Saxon ladies at this date.

The garb of these Anglo-Saxon ladies is extremely modest; very different from the older dresses of the Roman and Romano-Gallic period, and from what is understood to have been the costume of

A PATRIARCHAL FAMILY.

the older Germans, nothing is here uncovered but the face and hands. In the second cut, which represents a conversation between two persons of different sexes, and is taken from the same manu-

AN ANGLO-SAXON CONVERSATION.

script (fol. 31, r°), the lady presents exactly the same characteristics of costume and the same style of character; she is intended here to represent Faith, and in the original she is preaching to a crowd of people, of whom only one is introduced here that we may contrast the costume of the two sexes.

It has been stated in the preceding chapter, how the *camisia* (the French *chemise*) was added to the older Roman costume at the close of the western empire. It was no doubt adopted from the Franks by the Anglo-Saxons, for in the Anglo-Saxon glosses it is explained by the same word in an Anglo-Saxon form, *cemes* or *cemis*, and it no doubt held the place of the modern shift; that is, it was the garment next to the skin, and it was probably of linen, but, as may be supposed, it is never visible in the drawings. Over this was thrown the tunic, which also was derived, no doubt, from the Romans, and had preserved its Roman name in that of *tuneca*. It was a long full dress, almost concealing the feet, and had close sleeves reaching in rolls to the wrists, where they appear to have been usually confined by a bracelet. As the Anglo-Saxons had, in some cases, more than one word for the same article of dress, we often find a difficulty in identifying them. Such is the case with the word *cyrtel*, our modern *kirtle*. It is used in the old glosses to ex-

plain the Latin *tunica*, so that it seems to have been another name for the garment just described, or perhaps of an outer garment of the same kind, answering to the outer tunic of the Roman ladies. We certainly see on the ladies of the Anglo-Saxon illuminations two robes, one over the other; the outer of which is raised, and shows that they differ in colour and apparently in materials, while the inner dress can hardly be the *camisia*. This part of the dress was tightened round the waist by the girdle, which is often very broad, but sometimes so narrow as to be little more than a belt. Over all these was thrown a mantle, answering to the Roman *palla*, and derived apparently from it. The Anglo-Saxon name for it was, perhaps, a *wæfels;* at least that word is given in the Anglo-Saxon glosses as synonymous with the Latin *palla*. The mantle of the Anglo-Saxon ladies appears to have been formed exactly like the *palla*, and to have been put on and worn in the same manner. The Anglo-Saxon ladies, like the Franks, seem to have always worn a covering to the head; at least they are always represented thus covered in the engravings, and it will be best understood by our cuts. It appears to have been usually called simply a head-rail (*heafod-hrœgel*), or head-garment, for we are not aware of any special name given to it among the Anglo-Saxons. It appears sometimes as covering the head closely, and reaching no lower than the neck; at others, and in fact usually among the Anglo-Saxons, it sits looser and flows over the shoulders, and even beyond them, so as to form a kind of hood. Sometimes the lower part appears to be separate from that which covers the head, and the former may then be what the Anglo-Saxons called the *winpel*, or wimple.

We will now pay a visit to the Anglo-Saxon ladies in two other illuminated manuscripts of the period, and, if we learn not much more of their dress, we shall at least see them in other situations and characters. The works of the Anglo-Saxon artists of this period are singularly characterized by their spirited sketchy style of drawing, which is quite peculiar to them, and executed with a skill we could hardly expect, and of which the two manuscripts just mentioned are excellent examples. The first is a fine manuscript in the Harleian library in the British Museum (MS. Harl., No. 603), containing a copy of the Book of

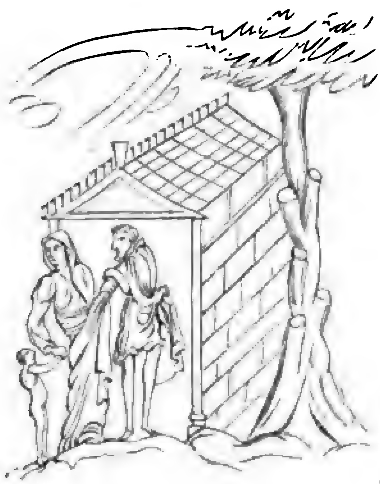
A GROUP OF ANGLO-SAXON WOMEN.

Psalms in Latin, profusely illustrated with these sketches. I give in the preceding cut, as an example of its style, a small group of Anglo-Saxon women, evidently all in a state of excitement; the two foremost seem especially agitated, while the one behind appears to be possessed with a degree of quiet dignity which is not easily ruffled. The second of our manuscripts is an equally fine and valuable volume (MS. Cotton. Claudius, B. IV.), containing a copy of the Anglo-Saxon translation of the Pentateuch by one of our most celebrated Anglo-Saxon prelates, Alfric of Canterbury. It is, like the other manuscript I am now using, largely illustrated, in a different style of art, but still the drawings are often as full of spirit as they are truthful. I give, in the next cut, an

AN ANGLO-SAXON FAMILY.

example from this manuscript (fol. 46, v°). It is intended in the original to represent the patriarch Jacob and his wife Leah, and his two sons by her handmaid Zilpah, Gad and Asher. It was a peculiar characteristic of the draughtsmen of the middle ages, and especially in the illuminated manuscripts, that, whatever might be the subject, they invariably drew it in the costume and manners of their own time. The scene before us may be described in entire correctness as an Anglo-Saxon family group—the head of the family and his wife seated on their settle, or double seat, and accompanied by their two boys. The father is dressed in his in-door costume; their

mother in the full dress of the Anglo-Saxon dame, as just described; the eldest of the boys has reached the age at which he is allowed to have at least a mimic sword. Our last cut on the present occasion is taken from the previously-described manuscript of the Psalms (MS. Harl., No. 603, fol. 15, v°). It represents a man, with a woman and child, at the entrance to what is, perhaps, intended to be a temple. It is the same style of costume, with the exception of the child, which is perfectly naked. Perhaps this is characteristic of a lower class of society.



Our coloured plate is another scriptural subject from the manuscript of Alfric's version of the Pentateuch (MS. Cotton. Claudius, B. IV., fol. 51, v°), and it may be taken as a very good example of the Anglo-Saxon idea of a patriarchal family. It is true that it represents the children of Jacob with their mothers, Leah and Rachel, and their handmaids, Zilpah and Bilhah. To the left we see Rachel and her single son, and Leah with her six—her daughter is not counted; to the right, Bilhah and Zilpah have respectively their two sons (Gen. xxix., xxx.). The costume of Anglo-Saxon ladies and Anglo-Saxon boys is here very well shown; but there is one peculiarity which is deserving of special notice, the colour of the hair—sky-blue. Blue hair is certainly not natural, and can only have been given, as apparently a favourite colour, by artificial means—by powder, or by the process of dyeing. It seems to have been equally a favourite colour with both sexes. Unfortunately, the Anglo-Saxon ladies are invariably represented in the illuminations of the manuscripts with the head covered with the head-rail. There is one exception: when Eve appears in Paradise with no covering of any kind for any other part of her body, it is not to be expected that she would have a covering for her head, and accordingly we find her in her hair. Her hair is blue. We trace in other pictorial manuscripts this taste of the Anglo-Saxons for blue hair. It must, of course, have been coloured artificially, either by a dye or by powder.

(*To be continued.*)

A NEW THEORY OF ACHILLES' SHIELD.

BY R. A. PROCTOR, B.A., F.R.A.S.

A DISTINGUISHED classical authority has remarked that the description of Achilles' shield occupies an anomalous position in Homer's "Iliad." On the one hand, it is easy to show that the poem—for the description may be looked on as a complete poem—is out of place in the "Iliad;" on the other, it is no less easy to show that Homer has carefully led up to the description of the shield, by a series of introductory events.

I propose to examine, briefly, the evidence on each of these points, and then to exhibit a theory respecting the shield which may appear *bizarre* enough on a first view, but which seems to me to be supported by satisfactory evidence.

An argument commonly urged against the genuineness of the "Shield of Achilles" is founded on the length and laboured character of the description. Even Grote, whose theory is that Homer's original poem was not an *Iliad*, but an *Achilleis*, has admitted the force of this argument. He finds clear evidence that from Book II. to Book XX., Homer has been husbanding his resources for the more effective description of the final conflict. He therefore concedes the possibility that the "Shield of Achilles" may be an interpolation—perhaps the work of another hand.

It appears to me, however, that the mere length of the description is no argument against the genuineness of the passage. Events have, indeed, been hastening to a crisis up to the end of Book XVII., and the action is checked in a marked manner by the "Oplopœia" in Book XVIII. Yet it is quite in Homer's manner to introduce, between two series of important events, an interval of comparative inaction, or at least of events wholly different in character from those of either series. We have a marked instance of this in Books IX. and X. Here the appeal to Achilles and the night-adventure of Diomed and Ulysses are interposed between the first victory of the Trojans and the great struggle in which Patroclus is slain, and Agamemnon, Ulysses, Diomed, Machaon, and Eurypylus wounded.* In fact, one cannot doubt that in such an arrangement Homer exhibits admirable taste and judgment. The contrast

* Another well-known instance, where "Patroclus sent in hot haste for news by a man of the most fiery impatience, is button-held by Nestor, and though he has no time to sit down, yet is obliged to endure a speech of 152 lines," is accounted for by Gladstone in a different manner.

between action and inaction, or between the confused tumult of a heady conflict and the subtle advance of the two Greek heroes, is conceived in the true poetic spirit. The dignity and importance of the action, and the interest of the interposed events, are alike enhanced. Indeed, there is scarcely a noted author whose works do not afford instances of corresponding contrasts. How skilfully, for example, has Shakespeare interposed the "bald, disjointed chat" of the sleepy porter, between the conscience-wrought horror of Duncan's murderers, and the "horror, horror, horror" which "tongue nor heart could not conceive nor name," of his faithful followers. Nor will the reader need to be reminded of the frequent and effective use by Dickens of the contrast between the humorous and the pathetic.

The laboured character of the description of the shield is an argument—though not, perhaps, a very striking one—of the independent origin of the poem.

But the arguments on which I am disposed to lay most stress lie nearer the surface.

Scarcely any one, I think, can have read the description of the shield without a feeling of wonder that Homer should describe the shield of a mortal hero as adorned with so many and such important objects. We find the sun and moon, the constellations, the waves of ocean, and a variety of other objects, better suited to adorn the temple of a great deity than the shield of a warrior, however noble and heroic. The objects depicted even on the Ægis of Zeus are much less important. There is certainly no trace in the "Iliad" of a wish on Homer's part to raise the dignity of mortal heroes at the expense of Zeus, yet the Ægis is thus succinctly described:—

> "Fring'd round with ever-fighting snakes, through it was drawn to life
> The miseries and deaths of fight; in it frown'd bloody Strife,
> In it shin'd sacred Fortitude, in it fell Pursuit flew,
> In it the monster Gorgon's head, in which held out to view
> Were all the dire ostents of Jove."
>
> Chapman's Translation.

Five lines here, as in the original, suffice for the description of Jove's Ægis, while one hundred and thirty lines are employed in the description of the celestial and terrestrial objects depicted on the shield of Achilles.

Another circumstance attracts notice in the description of Achilles' armour—the disproportionate importance attached to the shield. Undoubtedly, the shield was that portion of a hero's

armour which admitted of the freest application of artistic skill. Yet this consideration is not sufficient to account for the fact, that while so many lines are given to the shield, the helmet, corselet, and greaves are disposed of in four.

But the argument on which I am inclined to lay most stress, is the occurrence *elsewhere* of a description which is undoubtedly only another version of the "Shield of Achilles." The "Shield of Hercules" occurs in a poem ascribed to Hesiod. But whatever opinion may be formed respecting the authorship of the description, there can be no doubt that it is not Hesiod's work. It exhibits no trace of his dry, didactic, somewhat heavy style. Elton ascribes the "Shield of Hercules" to an imitator of Homer, and in support of this view points out those respects in which the poem resembles, and those in which it is inferior to, the "Shield of Achilles." The two descriptions are, however, absolutely identical in many places; and this would certainly not have happened if one had been an honest imitation of the other. And those parts of the "Shield of Hercules" which have no counterparts in the "Shield of Achilles," are too well conceived and expressed to be ascribed to a very inferior poet—a poet so inferior as to be reduced to the necessity of simply reproducing Homer's words in other parts of the poem. Those parts which admit of comparison—where, for instance, the same objects are described, but in different terms—are certainly inferior in the "Shield of Hercules." The description is spoiled by the addition of unnecessary or inharmonious details. Elton speaks, accordingly, of these portions as if they were expansions of the corresponding parts of the "Shield of Achilles." This seems to me a mistake. I am disposed to ascribe both descriptions to the same poet. It is not necessary for the purposes of my theory that this poet should be Homer, but I think both descriptions show undoubted traces of his handiwork. Indeed, all known imitations of Homer are so easily recognizable as the work of inferior poets, that I should have thought no doubt could exist on this point, but for the attention which the German theory respecting the "Iliad" has received. Assigning both poems to Homer, I look on the "Shield of Hercules," not as an expansion (in parts) of the "Shield of Achilles," but as an earlier work of Homer's, improved and pruned by his maturer judgment, when he desired to fit it into the plan of the "Iliad." Or, rather, each poem may be looked on as an abridgment (the "Shield of Hercules" the earlier) of an independent work on a subject presently to be mentioned.

It is next to be shown that in the events preceding the

"Oplopœia," there is a preparation for the introduction of a separate poem.

In the first place, every reader of Homer is familiar with the fact that the poet constantly makes use, when occasion serves, of expressions, sentences, often even of complete passages, which have been already applied in a corresponding, or occasionally even in a wholly different relation. The same epithets are repeatedly applied to the same deity or hero. A long message is delivered in the very words which have been already used by the sender of the message. In one well-known instance (in Book II.), not only is a message delivered thus, but the person who has received it repeats it to others in precisely the same terms. In the combat between Hector and Ajax (Book VI.), the flight of Ajax' spear and the movement by which Hector avoids the missile, are described in six lines, differing only as to proper names from those which had been already used in describing the encounter between Paris and Menelaus (Book III.).

This peculiarity would be a decided blemish in a written poem. Tennyson, indeed, occasionally copies Homer's manner—for instance, in "Enid," he twice repeats the line,

"As careful robins eye the delver's toil;"

but with a good taste which prevents the repetition from becoming offensive. The fact is, that the peculiarity marks Homer as the *singer*, not the *writer*, of poetry. I would not be understood as accepting the theory, according to which the "Iliad" is a mere string of ballads. I imagine that no one who justly appreciates that noble poem would be willing to countenance such a theory. But that the whole poem was sung by Homer at those prolonged festivals which formed a characteristic peculiarity of Achaian manners, seems shown, not only by what we learn respecting thelater "rhapsodists," but by the internal evidence of the poem itself.*

Homer, reciting a long and elaborate poem of his own composition, occasionally varying the order of events, or adding new episodes, extemporized as the song proceeded, would exhibit the peculiarity invariably observed in the "improvisatore," of using, more than once, expressions, sentences, or passages which happened

* Besides Homer's reference, both in the "Iliad" and "Odyssey," to poetic recitations at festivals, there is the well-known invocation in Book II. To what purpose would the mere writer of poetry pray for an increase of his physical powers? Nothing could be more proper, says Gladstone, if Homer were about to recite; nothing less proper if he were engaged on a written poem.

to be conveniently applicable. The art of extemporizing depends on the capacity for composing fresh matter while the tongue is engaged in the recital of matter already composed. Any one who has watched a clever improvisatore cannot fail to have noticed that, though gesture is aptly wedded to words, the thoughts are elsewhere. In the case, therefore, of an improvisatore, or even of a rhapsodist reciting from memory, the occasional recurrence of a well-worn form of words, serves as a relief to the strained invention or memory.

We have reason, then, for supposing that if Homer had, in his earlier days, composed a poem which was applicable, with slight alterations, to the story of the "Iliad," he would endeavour, by a suitable arrangement of the plan of his narrative, to introduce the lines whose recital had long since become familiar to him.

Evidence of design in the introduction of the "Shield of Achilles" certainly does not seem wanting.

It is not necessary to the plot of the "Iliad" that Achilles should lose the celestial armour given to Peleus as a dowry with Thetis. On the contrary, Homer has gone out of his way to render the labours of Vulcan necessary. Patroclus has to be so ingeniously disposed of that while the armour he had worn is seized by Hector, his body is rescued, as are also the horses and chariot of Achilles.

We have the additional improbability that the armour of the great Achilles should fit the inferior warriors Patroclus and Hector. Indeed, that the armour should fit Hector, or rather, that Hector should fit the armour, the aid of Zeus and Mars has to be called in—

> "To this Jove's sable brows did bow; and he made fit his limbs
> To those great arms, to fill which up the war-god enter'd him
> Austere and terrible, his joints and every part extends
> With strength and fortitude."
>
> Chapman's Translation.

It is clear that the narrative would not have been impaired in any way, while its probability and consistency would have been increased, if Patroclus had fought in his own armour. The death of Patroclus would in any case have been a cause sufficient to arouse the wrath of Achilles against Hector—though certainly the hero's grief for his armour is nearly as poignant as his sorrow for his friend's death.

It appears probable, then, that the description of Achilles' Shield is an interpolation—the poet's own work, however, and brought in by him in the only way he found available. The descrip-

tion clearly refers to the same object which is described (here, also, only in part) in the Shield of Hercules. The original description, doubtless, included all that is found in both "shields," and probably much more.

What, then, was the object to which the original description applied? An object, I should think, far more important than a warrior's shield. I imagine that any one who should read the description without being aware of its accepted interpretation, would consider that the poet was dealing with an important series of religious sculptures, possibly that he was describing the dome of a temple adorned with celestial and terrestrial symbols.

In Egypt, there are temples of a vast antiquity, having a dome, on which a zodiac—or, more correctly, a celestial hemisphere—is sculptured with constellation-figures. And we now learn, from ancient Babylonian and Assyrian sculptures, that these Egyptian zodiacs are in all probability merely copies (more or less perfect) of yet more ancient Chaldæan zodiacs. One of these Babylonian sculptures is figured in Rawlinson's "Ancient Monarchies." It seems probable that in a country where Sabæanism, or star-worship, was the prevailing form of religion, yet more imposing proportions would be given to such zodiacs than in Egypt.

My theory, then, respecting the Shield of Achilles is this—

I conceive that Homer, in his eastern travels, visited imposing temples devoted to astronomical observation and star-worship; and that nearly every line, in both shields, is borrowed from a poem in which he had described a temple of this sort, its domed zodiac, and those illustrations of the labours of different seasons and of military or judicial procedures, which the astrological proclivities of star-worshippers led them to associate with the different constellations.

I think there are arguments of some force to be urged in support of this theory, fanciful as it may seem.

In the first place, it is necessary that the constellations recognized in Homer's time (not necessarily, or probably, *by* Homer) should be distinguished from later inventions.

Aratus, writing long after Homer's date, mentions forty-five constellations. These were probably derived, without exception, from the globe of Eudoxus. Remembering the tendency which astronomers have shown, in all ages, to add to the list of constellations, we may assume that in Homer's time the number was smaller. Probably there were some fifteen northern and ten southern constellations, besides the twelve zodiacal signs. The smaller constellations mentioned by Aratus, doubtless formed parts

of larger figures. Any one who studies the heavens will recognize the fact that the larger constellations have been robbed of their just proportions to form the smaller asterisms. Corona Borealis was the right arm of Bootes, Ursa Minor was a wing of Draco (now wingless, and no longer a dragon), and so on.

Secondly, it is necessary that the actual appearance of the heavens, with reference to the position of the pole in Homer's time, should be indicated. For our present purpose, it is not necessary that we should know the exact date at which the most ancient of the zodiac-temples were constructed (or to which they were made to correspond). There are good reasons, though this is not the proper place for dwelling upon them, for supposing that the great epoch of reference amongst ancient astronomers, preceded the Christian era by about 2200 years. Be this as it may, any epoch between the date named, and the probable date at which Homer flourished—say nine or ten centuries before the Christian era—will serve equally well for our present purpose. Now, if the effects of equinoctial precession be traced back to such a date, we are led to notice two singular and not uninteresting circumstances. First, the pole of the heavens fell in the central part of the great constel-tion Draco; and, secondly, the equator fell along the length of the great sea-serpent, Hydra, in one part of its course, and elsewhere to the north of all the ancient aquatic constellations,* save that one-half of the northernmost fish (of the zodiac pair) lay north of the equator. Thus, if a celestial sphere were constructed with the equator in a horizontal position, the Dragon would be at the summit, Hydra would be extended horizontally along the equator—but with his head and neck reared above that circle, and Argo, Cetus, Capricornus, Piscis Australis, and Pisces—save one-half of the northernmost—would lie *below* the equator. It may also be mentioned that all the bird-constellations were then, as now, clustered together not far from the equator—Cygnus (the farthest from the equator) being ten degrees or so nearer to that circle than at present.

Now let us turn to the two shields, and see whether there is anything in them to connect them with zodiac-temples, or to remind us of the relations exhibited above. To commence with the Shield of Achilles, the opening lines inform us that there appeared—

> "The unwearied Sun, the Moon completely round
> The starry lights that heav'n's high convex crown'd,
> The Pleiads, Hyads, with the northern team,
> And great Orion's more refulgent beam."

* I exclude Delphinus as later than Homer's time, though mentioned by Aratus.

And here, in Achilles' shield, the list of constellations closes; but it is remarkable that in the Shield of Hercules, while the above lines are wanting, we find lines which clearly point to other constellations. Remembering what has just been stated about Draco, it seems, at the least, a singular coincidence that we should find the centre or boss of the shield occupied by a dragon:—

> "The scaly horror of a dragon, coil'd
> Full in the central field, unspeakable,
> With eyes oblique retorted, that aslant
> Shot gleaming flame."*
>
> Elton's Translation.

We seem, also, to find a reference to the above-named relations of the aquatic constellations, and specially to the constellation Pisces:—

> "In the midst,
> Full many dolphins chas'd the fry, and show'd
> As though they swam the waters, to and fro
> Darting tumultuous: two of silver scale
> Panting above the wave."

For we learn from both "shields" that the waves of ocean were figured in a position corresponding with the above-mentioned position of the celestial equator, beneath which—that is, *in the ocean,* on our assumption—the aquatic constellations were figured. The description of the ocean in the Shield of Hercules contains also some lines, in which we seem to see a reference to the bird-constellations close above the equator:—

> "Rounding the utmost verge the ocean flow'd
> As in full swell of waters, and the shield
> All variegated with whole circle bound.
> Swans of high-hovering wing there clamour'd shrill,
> Who also skimm'd the breasted surge with plume
> Innumerous; near them fishes 'midst the waves
> Frolick'd in wanton bounds."

In the Shield of Achilles no mention is made of Perseus, but in the Shield of Hercules this well-known constellation seems described in the lines—

> "There was the knight of fair-hair'd Danae born,
> Perseus; nor yet the buckler with his feet
> Touch'd nor yet distant hover'd, strange to see,
> For nowhere on the surface of the shield

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* Compare the description of Draco by Aratus:—

> "Swol'n is his neck—eyes charg'd with sparkling fire
> His crested head illume. As if in ire
> To Helice he turns his foaming jaw
> And darts his tongue, barb'd with a blazing star."
>
> Lamb's Translation.

He rested; so the crippled artist-god
Illustrious fram'd him with his hands in gold.
Bound to his feet were sandals wing'd; a sword
Of brass, with hilt of sable ebony,
Hung round him from the shoulders by a thong.
. . . . The visage grim
Of monstrous Gorgon all his back o'erspread;
. . . . the dreadful helm
Of Pluto clasp'd the temples of the prince."

I think there is an obvious reference to the twins Castor and Pollux (the wrestler and boxer of mythology) in the words—

"But in another part
Were men who wrestled, or in gymnic fight
Wielded the cestus."

Orion is not mentioned by name in the Shield of Hercules as in the other; but Orion, Lepus, and the two dogs seem referred to:—

"Elsewhere men of chase
Were taking the fleet hares; two keen-toothed dogs
Bounded beside, these ardent in pursuit,
Those with like ardour doubling in their flight."

In each shield we find a reference to the operations of the year—hunting and pasturing, sowing, ploughing, and harvesting. It is hardly necessary to point out the connection between these operations and astronomical relations. That this connection was fully recognized in ancient times is shown in the "Works and Days" of Hesiod. We find also in Egyptian zodiacs clear evidence that these operations, as well as astronomical symbols or constellations, found a record in sculptured domes.

The judicial, military, and other proceedings described in the Shield of Achilles were also supposed by the ancients to have been influenced by the courses of the stars.

If we had no evidence that ancient celestial spheres presented the constellations above referred to, we might be disposed to attach less weight to the coincidences here presented; but the "Phenomena" of Aratus affords sufficient testimony on this point. In the first place, that work is of great antiquity, since Aratus flourished two centuries and a half before the Christian era; but it is well known that Aratus did not describe the results of his own observations. The positions of the constellations, as recorded by him, accord neither with the date at which he wrote nor with the latitude in which he lived. It is generally assumed—chiefly on the authority of Hipparchus—that Aratus borrowed his knowledge of astronomy from the sphere of Eudoxus; but we must go much farther back

even than the date of Eudoxus, before we can find any correspondence between the appearance of the heavens and the description given by Aratus. Thus we may very fairly assume that the *origin* of the constellations (as distinguished from their association with certain circles of the celestial sphere) may be placed at a date preceding, perhaps by many generations, that at which Homer flourished.

Indeed, there have not been wanting those who find in the ancient constellations the record of the early history of man. According to their views Orion is Nimrod—the "Giant," as the Arabic name of the constellation implies—the mighty hunter, as the dogs and hare beside him signify. The Centaur bearing a victim towards the altar is Noah; Argo, the stern of a ship, is the ark, as of old it might be seen on Mount Ararat. Corvus is the crow sent forth by Noah, and the bird is placed on Hydra's back to show that there was no land on which it could set its foot. The figure now called Hercules, but of old Engonasin, or the kneeler, and described by Aratus as "a man doomed to labour," is Adam. His left foot treads on the dragon's head, in token of the saying, "It shall bruise thy head;" and Serpentarius, or the serpent-bearer, is the promised seed.

Of course, if we accept these views, we have no difficulty in understanding that a poet so ancient as Homer should refer to the constellations which still appear upon celestial spheres. And, in any case, the mere question of antiquity presents, as we have already shown, little difficulty.

But there is a difficulty in one respect, a notice of which must close this paper, already carried far beyond the limits I had proposed to myself. It may be thought remarkable that heroes of Greek mythology, as Perseus and Orion, should be placed by Homer, or even by Aratus, in spheres which are undoubtedly of eastern origin.

Now it may be remarked, first, of Homer, that many acute critics consider the whole story of the "Iliad" to be, in reality, merely an adaptation of an eastern narrative to Greek scenes and names. It is pointed out, that, whereas the Catalogue in Book II. reckons upwards of 100,000 men, only 10,000 fought at Marathon; and, whereas there are counted no less than 1200 ships in the Catalogue, there were but 271 at Artemisium, and at Salamis but 378. However this may be, we have the distinct evidence of Herodotus that the Greek mythology was derived originally from foreign sources. He says, "All the names of the gods in Greece

were brought from Egypt," an opinion in which Diodorus and other eminent authorities concur. But it is the opinion of acute modern critics that we must go beyond Egyptian—to Assyrian, or Indian, perhaps even to Hebrew sources, for the origin of Greek mythology. Bryant traces nearly all the Greek myths to traditions of the dispersion of the Cuthites or Cuseans. And Layard has ascribed to Niebuhr the following significant remarks: "There is a want in Grecian art which neither I, nor any man now alive, can supply. There is not enough in Egypt to account for the peculiar art and the peculiar mythology which we find in Greece. That the Egyptians did not originate it I am convinced, though neither I, nor any man now alive, can say who were the originators. But the time will come when, on the borders of the Tigris and Euphrates, those who come after me will live to see the origin of Grecian art and Grecian mythology."

ON THE NEW THEORIES IN CHEMISTRY.

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No. IV.

We have seen, in the last article, that the molecule of most elements consists of two atoms, each having different and opposite properties, which in effect neutralize one another. If a molecule of hydrogen, H, H, be acted upon by a molecule of chlorine Cl, Cl, the result is two molecules of hydrochloric acid, H Cl, H Cl. If these molecules of hydrochloric acid be brought into contact with a molecule of sodium, a molecule of hydrogen is set free, and two molecules of chloride of sodium are formed, Na Cl, Na Cl; and if these be vaporized and acted upon by steam, at a high temperature, two molecules of hydrate of soda, Na HO, Na HO, will be the product, together with two molecules of hydrochloric acid.

$$\mathrm{Na\,Cl} + \mathrm{Na\,Cl} + 2(H_2O) = \mathrm{Na\,HO} + \mathrm{Na\,HO} + 2(\mathrm{H\,Cl}).$$

In the first instance, an atom of chlorine has replaced an atom of hydrogen, in the free molecule; in the second, sodium has replaced the second atom of hydrogen; and in the third, HO (hydroxyl) has replaced an atom of chlorine. One of these compounds, Na Cl, is ordinarily called a salt, and in general parlance, common salt;

in its constitution it in no way differs from the other three compounds; so that in whatever sense it is a salt, the others are salts. We may, therefore, say that a salt is a body in which an equilibrium exists between its constituent atoms, whether those atoms exercise their properties individually or in conjunction; by this is meant, either as simple elements, or as compounds, acting permanently as elements, as CN and CN.Fe, or for the time only, as radicals, as NO_3, SO_4, etc.; for, by acting on Na HO with $H_2 SO_4$, SO_4 moves over *en masse* to Na, its hydrogen uniting with HO to form water; thus:

$$2(Na\ HO) + H_2\ SO_4 = Na_2\ SO_4 + 2(H_2\ O).$$

Usually, salts are defined to be the compounds formed by the neutralization of a base by an acid, either wholly or in part—a base being that substance which has alkaline properties, or which turns red litmus, blue or yellow turmeric paper brown, and which has a peculiar soapy taste; an acid being a substance which turns blue litmus paper red, and has a sour taste. This view originated when compound bodies were regarded as made up of two constituent parts—the base, or alkaline, and the acid; it was then thought that such compounds as sulphuric acid were formed by the union of water HO, and anhydrous sulphuric acid SO_3, and that these were simply joined together, and that sulphuric acid existed, as such, in a salt—say sulphate of soda—but that the properties of the acid were more or less neutralizing, in proportion to the excess or deficiency of base. Now, it is clearly shown that this view is incorrect, for SO_3 has not what are termed acid properties; it does not redden litmus paper; it is a solid, silky-looking substance, not unlike white floss silk; and, if the fingers be perfectly dry, it can be handled with impunity: but, when dropped into water, the union between it and the water is so energetic, that a sound, similar to that produced by melted lead poured into water, is produced. When united with water, it has acid properties, and no amount of heat can separate from it that water which it has taken up to form the compound, which was formerly represented by the formula HO, SO_3. No exception can be taken to the terms acid and base, if used in an adjective sense, expressive of certain properties. Thus, sulphuric acid is an acid, because it reddens blue litmus paper, and has what is called an acid taste; and potash is a base, because it turns red litmus paper blue, and has the peculiar taste of an alkali; and when the two are mixed, they, between them, form a salt—not that, after mixture, either of them exists in that salt, but only part of the constituents of each, they having lost two molecules of water, one of

which was necessary to give acid properties to the sulphuric acid, and the other alkaline properties to the potassium; potassium remains combined with SO_4, and the formula of the body is $K_2 SO_4$; not that this is intended to be the rational formula of the compound, or to express the way in which the elements are grouped together; for, if we take baryta instead of potash, we have the sulphate $Ba SO_4$, and this can be formed by precipitating a soluble baryta salt, such as barytic chloride, with sulphuric acid; thus:

$$Ba Cl_2 + H_2 SO_4 = Ba SO_4 + 2 H Cl.$$

But the same compound can also be formed by acting on the sulphite with chlorine water, for the hypochlorous acid in chlorine water gives up its oxygen to the sulphite, $Ba SO_3$, converting it into $Ba SO_4$; in like manner, sulphide of barium can, by oxidation with nitric acid, be converted into the sulphate. In all these several ways can the sulphate of barium be formed, and therefore it cannot be said to result from the union of two groups of atoms bonded together in some inseparable manner; its molecule, however, is in a state of equilibrium, and the way in which this condition exists will be better understood after the saturation of molecules and the theory of types have been considered.

This is, perhaps, the best place for noticing a new nomenclature which is fast coming into general use, and one which expresses the nature of compounds much better than the old names. It has not been hitherto used in these articles, which are intended especially for those who have not made the new chemical theories their study, as it would, before explanation, have thrown difficulties in the way of rendering them as plain as the nature of the subject will admit of. Sulphuric acid, being a sulphate of hydrogen, and not, as was formerly considered, a combination of water and sulphuric acid, the term sulphuric acid is replaced by hydric sulphate; and this fairly expresses the nature of the body, hydrogen being basic and SO_4 chlorous. The hydrogen can be replaced by other metals according to their valency, atom for atom, in the case of monovalent elements; thus, $Na HSO_4$, formerly called bisulphate of soda, is now hydrosodic sulphate, expressive of the fact that it contains hydrogen, sodium, and SO_4; and $Na_2 SO_4$ is called sodic, or di-sodic sulphate. The nitrates, beginning with nitric acid HNO_3, consist of NO_3 and hydrogen, or other metals which can replace it; monovalent elements, taking the place of the one atom of hydrogen, form but one class of compounds, not two, as in $H_2 SO_4$, where there are two atoms of replaceable hydrogen; and divalent elements require two molecules

of the monobasic radical NO_3 to form nitrates; and trivalent elements, three molecules, etc. HNO_3, nitrate of hydrogen, is in the new nomenclature called hydric nitrate; and $Ag NO_3$, nitrate of silver, argentic nitrate; and $Ba(NO_3)_2$, barytic nitrate. Hydrochloric acid is called hydric chloride; and $Na Cl$, common salt, sodic chloride. The three phosphoric acids are termed respectively, HPO_3 hydric metaphosphate, $H_3 PO_4$ trihydric phosphate, and $H_4P_2O_7$ tetrahydric pyrophosphate. Rhombic phosphate of soda $Na_2 HPO_4$ is named hydro-di-sodic phosphate, $Na H_2 PO_4$ di-hydrosodic phosphate, and $Na_3 PO_4$ sodic or tri-sodic phosphate. It would occupy too much of our space to give all the changes which have been made; the illustrations of the different acids given will be sufficient to show the principle on which the changes have been made, viz., that of conveying by names a fair idea of the composition of the bodies which they are intended to designate. In Professor Williamson's "Chemistry for Students," this nomenclature is almost entirely employed.

Before concluding this brief statement of the constitution of compounds, it may be well to state that another view is held by some chemists, in which they regard salts, not as in a state of equilibrium, but as being bodies capable of undergoing, and ready to undergo, double decomposition; that is, as being in a state of unstable equilibrium. When carefully considered, the two views come to much the same thing, for at the moment a compound is formed it is in equilibrium, for the forces which have determined its composition must have proved superior to others with which it was previously in contact; and if all other forces could be withdrawn it would remain so, for it is only when, in contact, a greater force is brought to bear on its constituent elements than that which holds them together, that a decomposition can take place. No doubt the dynamical theory of the constitution of salts is true, but it does not seem to exclude the statical. The hydrated and anhydrous monoxides of potassium, sodium, etc., were formerly thought to differ from one another, in that the hydrated oxide was the anhydrous plus a molecule of water, the anhydrous oxide being represented by the formula KO, HO. If, however, KO, HO be heated to a white heat, it does not part with the HO. It has been shown, in a former article, that oxygen cannot combine with hydrogen in less proportion than two atoms of hydrogen to one of oxygen. Now, when potassium acts on water, the resulting compound is KHO, one atom of hydrogen, one of potassium, and one of oxygen, the second atom of hydrogen in the water being set free. The elements of water,

therefore, clearly do not exist in the hydrate; but changed water is there, so to speak—water which has changed one of its atoms of hydrogen for one of potassium; and this brings us to the way in which such compound bodies and their re-actions are now regarded. To Dr. Williamson we owe the method of viewing chemical decompositions, with reference to what is termed the water type, a system which gives a rational account of the interchanges and substitutions which take place when bodies re-act on one another. It should be understood that types are but representations, which have, perhaps, in some instances been carried to a somewhat fanciful extent; what is meant to be expressed by them is the bringing into view the re-acting substances by means of formulæ, and the expressing rationally the changes which take place between them. It is simply for clearness and convenience that they are written in a peculiar form; the same truths could be expressed if any other arrangement of the symbols were adopted.

Dr. Williamson took as the first type one molecule of water, which for convenience he wrote thus, $\frac{H}{H}O$; and on this type he says that most bodies can be represented which contain one atom of hydrogen, which can be replaced by a monovalent element such as potassium. For example, hydrate of potash, which is, as we have seen, water in which an atom of potassium has been substituted for one of hydrogen, is represented thus, $\frac{K}{H}O$; and anhydrous oxide of potassium, in which the other atom of hydrogen has been replaced by potassium, thus, $\frac{K}{K}O$. In these formulæ a rational account is given of the formation of these salts, and one which at a glance shows their constitution, and which is, moreover, truly in accordance with the method of their formation, and the type is not altered. The monobasic acid, nitric acid, is represented as being formed on the type of one molecule of water, by the substitution of a molecule of peroxide of nitrogen, NO_2, for one atom of hydrogen, $\frac{H}{NO_2}O$; and in like manner nitrate of potash is formed by the replacement of the other atom of hydrogen by potassium, thus, $\frac{K}{NO_2}O$; and that such is really what takes place is proved by the action of chloro-nitric acid, NO_2Cl, on water (chloro-nitric acid is formed by the action of chloro-phosphoric acid, $POCl_3$, on plumbic nitrate, $Pb(NO_3)_2$), for the radical NO_2 takes the place of one atom of hydrogen in a

molecule of water, which forms hydrochloric acid with the atom of chlorine in the acid; thus—

$$Cl\,NO_2 + {H \atop H}O = HCl + {NO_2 \atop H}O.$$

And again, by the action of anhydrous nitric acid N_2O_5 on water—

$${NO_2 \atop NO_2}O + {H \atop H}O = {NO_2 \atop H}O + {NO_2 \atop H}O.$$

In both these cases nitric acid is formed by direct substitution of NO_2 for H. A similar interchange of NO_2 for H takes place when nitric acid acts on benzole, $C_6 H_6$,

$$C_6 H_6 + HNO_3 = H_2 O + C_6 H_5 (NO_2),$$

resulting in the formation of nitro-benzole. This substitution of NO_2 is very frequent in organic chemistry, more so than in inorganic; it is the process by which cellulose is converted into gun-cotton, and, according to the strength of the acid used, as many as three molecules of NO_2 can be substituted for three atoms of hydrogen,

$$\underset{\text{(Cellulose.)}}{C_6 H_{10} O_5} + (HNO_3)_3 = \underset{\text{(Gun-cotton.)}}{C_6 H_7 (NO_2)_3 O_5} + 3(H_2 O).$$

The explosive substance nitro-glycerine is likewise the product of a similar substitution.

Sulphuric acid, which is bibasic, is represented on the type of two molecules of water, ${H_2 \atop H_2}O_2$, in which two atoms of hydrogen are replaced by the radical SO_2, called sulphuryl, ${SO_2 \atop H_2}O_2$.

Dr. Williamson has shown* that the chlorous radicals, SO_2, NO_2, can be removed from salts as effectually as the basylous elements hydrogen and potassium. He made experiments by acting on sulphuric acid with penta-chloride of phosphorus; and succeeded in forming the body $SO_2 Cl_2$, chloro-sulphuric acid. The decomposition takes place in two successive stages: the first consists in the replacement of hydroxyl, HO, by an atom of chlorine, forming $SO_2 HO Cl$; and the second by the replacement of the second hydroxyl by another atom of chlorine, forming SO_2Cl_2, thus showing that SO_2, the radical of sulphuric acid, is capable of replacing or is equivalent to two atoms of hydrogen, and proving the bibasic character of sulphuric acid.

* Proceedings of the Royal Society, vii. 11.

Dr. Williamson says, "Had this radical been divisible like an equivalent quantity of a monobasic acid, we should have obtained a mixture, not a compound, of the chloride with the hydrate; or, at least, the products of decomposition of that mixture." When sulphuric acid is decomposed by a metal, if the acid be dilute, its hydrogen is replaced by the metal, as is seen in the preparation of hydrogen from zinc and sulphuric acid; but if zinc act on strong oil of vitriol under the influence of heat, sulphurous acid, SO_2, is given off, showing that it is held in sulphuric acid in a manner similar to hydrogen. $SO_2\,Cl_2$ decomposes water with violence, if the acid be in excess, hydrochloric acid being formed by the replacement of two atoms of hydrogen in two molecules of water by SO_2.

$$SO_2\,Cl_2 + 2\,(H_2\,O) = SO_2\,H_2\,O_2 + 2\,H\,Cl.$$

And from this reaction, we must regard sulphuric acid as water, in which two atoms of hydrogen have been replaced by the direct substitution of the acid radical SO_2. In the same way alcohol, $C_2\,H_6\,O$, which in organic chemistry seems to take the place of water in inorganic, is water in which an atom of hydrogen has been replaced by an atom of the radical ethyl ($C_2\,H_5$)—

$$\begin{matrix} H \\ H \end{matrix} O \quad \begin{matrix} C_2H_5 \\ H \end{matrix} O$$

and is a salt as truly as sulphuric acid or sulphate of soda. It is an oxide of hydrogen and ethyl, just as potash is an oxide of hydrogen and potassium; because for the second atom of hydrogen in water, not replaced by ethyl, potassium can be substituted by the action of that metal on vinic alcohol, just as hydrate of potash was formed by its action on water.

$$\begin{matrix} C_2H_5 \\ H \end{matrix} O \quad \begin{matrix} C_2H_5 \\ K \end{matrix} O.$$

If the remaining atom of hydrogen in alcohol, which is called typical hydrogen, because it belongs to the typical water, be replaced by $C_2\,H_5$, we have—

$$\begin{matrix} C_2\,H_5 \\ H \end{matrix} O \quad \begin{matrix} C_2\,H_5 \\ C_2\,H_5 \end{matrix} O, \quad \text{or} \quad C_4\,H_{10}\,O, \text{ vinic ether,}$$

which corresponds to the anhydrous oxide of potassium, $\frac{K}{K}O$, in which both atoms of the hydrogen of the water have been replaced by potassium, and may be called ethylic oxide, just as alcohol may be called hydro-ethylic oxide. That ether is really formed by the substitution of $C_2\,H_5$ for H in vinic alcohol, and that it is formed on the type of a molecule of water, is seen when iodide of ethyl, $C_2\,H_5\,I$,

acts on potassium alcohol, $\frac{C_2 H_5}{K} O$; for if alcohol be water, in which one atom of hydrogen is replaced by ethyl, then the second atom can be replaced by potassium; and if iodide of ethyl (which is made by the action of phosphorous iodide on alcohol), be caused to re-act on it, a substitution of ethyl for potassium takes place, the iodine uniting with the ethyl; thus—

$$\frac{C_2 H_5}{K} O + C_2 H_5 I = I K + \frac{C_2 H_5}{C_2 H_5} O;$$

and this hydrogen is not only replaceable by ethyl, but by methyl, CH_3, by amyl, $C_5 H_{11}$, and by the other alcohol radicals, forming compound ethers; as $\frac{C_2 H_5}{CH_3} O$, vino-methylic ether, and $\frac{C_2 H_5}{C_5 H_{11}} O$, vino-amylic ether, which are obtained by the action of methylic iodide, $CH_3 I$, and amylic iodide, $C_5 H_{11} I$, respectively on potassio-vinic alcohol. The reverse of these reactions is also true, for when iodide of ethyl is treated with potassic hydrate, the potassium and ethyl change places, alcohol and potassic-iodate being formed—

$$\frac{K}{H} O + C_2 H_5 I = \frac{C_2 H_5}{H} O + K I$$

so that, indirectly, by the action of potassium on water, and by its replacement by $C_2 H$, we prove what we at first rather took for granted, viz., that alcohol is water in which an atom of hydrogen is replaced by the compound radical ethyl. If possible, a clearer proof of the constitution of ether is afforded by the constant process of Etherification, so ably explained by Professor Williamson in his paper in the "Philosophical Magazine." That process is effected by the action of sulphuric acid on alcohol; two parts by volume of alcohol are mixed with three of sulphuric acid, the heat evolved, which is considerable, causes the formation of sulpho-vinic acid, by the substitution of $C_2 H_5$ for H in the molecule of sulphuric acid; thus—

$$\frac{C_2 H_5}{H} O + \frac{H}{H} SO_4 = \frac{H}{H} O + \frac{C_2 H_5}{H} SO_4$$

(Sulpho-vinic acid.)

On raising the temperature to 135° C., the sulpho-vinic acid acts on another molecule of alcohol, in which the $C_2 H_5$ of the acid takes the place of the hydrogen in the alcohol; thus—

$$\frac{C_2 H_5}{H} SO_4 + \frac{C_2 H_5}{H} O = \frac{C_2 H_5}{C_2 H_5} O + \frac{H}{H} SO_4.$$

The further explanation of this process will be given in the next article.

* Phil. Mag. (3), xxxvii. 350.

ASTRONOMICAL NOTES FOR JUNE.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

IN the month of June, all the large planets will be visible at some time in the course of the night, but three only of them in the evening.

MERCURY will be at his greatest elongation on the morning of the 17th, being gibbous before that time and horned after it. He will set on the first day at 9h. 50m., or 1h. 45m. after sunset; on the 17th at 9h. 58m., or 1h. 42m. after sunset; and on the last day at 9h. 6m., or 49m. after sunset. Until quite the end of the month, therefore, he will be conspicuous in the evening, at first in the constellation Gemini, and afterwards in Cancer. On the 6th, he will be very near ϵ Geminorum, a star of the third magnitude; from the 16th to the 18th, he will be almost exactly south, by a few degrees, of the well-known twins, Castor and Pollux.

VENUS is horned throughout the month. She will be constantly approaching the Earth, but as the proportion of illuminated surface turned towards us is becoming smaller, her apparent brilliancy, which will continually increase until June 9th, will, after that day, slowly diminish. She will set on the first day at 11h. 22m., then earlier each night until, on the last day, the time of setting will be 9h. 20m. On the 22nd she will be in conjunction with the Moon, then a *very* small crescent of only two days old, at 8h. 40m. in the evening. Early in the month she will pass from the constellation Gemini into Cancer, and continue there until the end of it; being stationary on the 24th, her right ascension will afterwards diminish instead of increasing as before.

MARS will be visible in the early morning, rising at the beginning of the month about half-past two, and at the end of it about half-past one. He passes, towards the end of the month, from Aries into Taurus, being near the Pleiades about the 27th. On the evening of the 17th, he is in conjunction with the Moon, and may, therefore, on the morning of that day be seen near her small crescent.

JUPITER will also be conspicuous in the mornings, rising, by the end of the month, a little before midnight. His position in the sky will be in the constellation Pisces, and he will be in conjunction with the Moon on the evening of the 14th. Next month we shall have occasion to commence calling attention to the more interesting of the phenomena of his satellites.

SATURN will be visible for the whole night throughout the month, rising on the first day at 6h. 51m. in the evening, and on the last day at 4h. 49m. He will be within a short distance of β Scorpii, a star of the second magnitude, about a degree to the north of it. On the 30th, he will be very near the Moon, being in conjunction with her on the morning of the 1st of July.

OCCULTATIONS OF STARS BY THE MOON.—Four of these phenomena will, during the month of June, be observable within tolerably early hours of the night. They are as follows:—

DAY.	NAME OF STAR.	M.	DISAPPEARANCE.		REAPPEARANCE.	
			MEAN TIME.	V.	MEAN TIME.	V.
			h. m.	°	h. m.	°
June 1	94 Virginis	6	7 20	42	8 35	241
„ 10	μ Capricorni	5	11 50	11	12 30	305
„ 27	48 Virginis	6	8 16	85	9 28	273
„ 30	η Libræ	6	12 45	40	13 8	2

THE MOON.—The Moon will be full on the fifth day at 6h. 55m. in the morning. On the first evening or two, therefore, Kepler, and afterwards Aristarchus, may be studied with advantage. The tract known as the Mare Humorum, with Gassendi immediately to the north of it, will be at that time the most remarkable region in the more southern part of the Moon. As soon as the terminator has retreated a little in the waning Moon, the Mare Crisium will be found very interesting. The last quarter occurs on the morning of the 13th, the conjunction at 2h. 45m. on the afternoon of the 20th. The Mare Crisium may again be seen on the 24th, and shortly afterwards the Mare Fœcunditatis. On the 25th, Posidonius, preceding the advent of the Mare Serenitatis, will be in view; also Plinius on its southern boundary, and, in a more southern region of the Moon, the remarkable object called Theophilus. During the night of the 26th, Hipparchus, nearly in the Moon's centre, and the craters near Archimedes, will come into sight. The next morning (the 27th) at 5h. 51m., our satellite will be in her first quarter. Eratosthenes and Schröter will be visible in the evening, and Copernicus, with the Mare Imbrium to the north, on that of the 28th.

APRIL OBSERVATIONS.—Although the night was, this year, not favourable for the observation of the April meteors, yet intelligence

has reached us that *some* were seen. It is as yet too early to state whether a result of any significance was arrived at.—Brorsen's comet was first seen by Professor Bruhns, at Leipzig, on the night of the 13th of April, and was observed the following evening by C. F. W. Peters (son of Prof. C. A. F. Peters), at Altona. It was, on April 14, very near ϵ Tauri, and was somewhat less than a degree distant from the place assigned to it by Bruhns' ephemeris. In appearance it was pretty bright. It is not probable that it will be visible, even with powerful object-glasses, in any part of June.

Recent Announcements.—Allusion should be made here to a recent new determination of the parallax of that bright star in the southern hemisphere, α Centauri, which has been executed by Prof. Moesta, Director of the Observatory at Santiago, in Chili, and published in the "Astronomische Nachrichten" (No. 1688). It is founded on more than two hundred observations made with the meridian-circle of that observatory, and extending from October, 1860 to May, 1864. It is well known that this is the nearest of all the fixed stars (at least, of those of which measurements of distance have been attempted), and is not much more than half the distance of that famous star in our own hemisphere, 61 Cygni. Henderson's observations at the Cape of Good Hope (corrected by Peters) gave a parallax of $0''\cdot976$; Maclear's, at the same place, of $0''\cdot919$. The result now arrived at by Moesta is $0''\cdot88$, with a probable error of $0''\cdot068$. It may safely be assumed, therefore, that the actual parallax is about nine-tenths of a second, which would give a distance of somewhat more than twenty-one billions of miles.

Encke's Comet.—This very remarkable comet is now again approaching the Earth. It is expected to be visible (but only by the help of powerful object-glasses) towards the end of June, in the constellation Aries. During the months of July and August it will be continually approaching the Earth, and become more generally seen, though probably always telescopic, and very faint. A few words may be here devoted to its previous history, which is, however, pretty well known to all who take any interest in astronomy.

It appears to have been first seen by Méchain, in the year 1786, and was afterwards re-discovered by Miss Herschel, in 1795; by Thulis, Pons, and others, independently, in 1805; and by Pons again, in 1818. On the occasion of the latter appearance (when it passed its perihelion in January, 1819), it was taken in hand by the illustrious late Director of the Berlin Observatory, Professor Encke, then only assistant at Seeberg, near Gotha. In a paper, printed in the

"Berliner Astronomisches Jahrbuch" for 1822, he showed that the successive discoveries above-mentioned were, in fact, those of the same comet, which revolved round the Sun in little more than three years, and had, consequently, since 1786, passed its perihelion on seven other occasions, without being seen. He predicted that it would return to perihelion in May, 1822. And, indeed, it was observed in June that year, by Rumker, at Paramatta, near Sydney, in Australia; also, at the next appearance in the autumn of 1825, by several observers in the northern hemisphere. The completeness of Encke's investigations led astronomers by common consent to call the comet after his name, though he himself always continued to call it Pons's comet. Following it up at subsequent appearances, he established the remarkable fact (which he conjectured even so early as 1819), that it is subject to some resistance in its motion which continually retards its progress, and slightly diminishes its periodic time. This would appear to be due to the ethereal medium which, we have every reason to suppose, pervades all space, and which, powerless to any sensible extent upon the planetary masses, is able to produce appreciable effects upon the motions of this tiny body; for Encke found, after carefully allowing for all other causes of disturbance, that the comet was subject to an additional opposing force of a purely tangential nature. The effect is, that the attraction of the Sun upon it becomes continually more powerful in comparison with its own projectile force, so that it approaches the Sun more nearly each revolution, and, having thus a smaller distance to traverse, accomplishes it in a shorter time. The amount of this is about 0·11 of a day, or 2½ hours; so that whereas the period from the perihelion passage in 1819 to that in 1822 was 1211·66 days, that from the last perihelion passage in 1865 (at which appearance the comet was seen only in the southern hemisphere) until the forthcoming one this summer, will be only 1210·11 days.

The usual appearance of Encke's comet is that of a simple nebulous luminosity, of the diameter, when greatest, of nearly one third of a degree, with a necleus sometimes comparable to a star of the fifth magnitude (and, therefore, on some occasions visible to the naked eye), and a little tail, which occasionally shows itself towards the epoch of perihelion passage. One of the apparitions at which it was most favourably situated for observation, was that in the autumn of the year 1838. That return was also remarkable for the comet's having made a near approach to the planet Mercury, which furnished the means, by the perturbing effect upon the motions of

the comet, of determining, with considerably greater exactness than had previously been possible, the mass of the planet.

The most remarkable appearance, however, of this comet was that which occurred in 1848. In November of that year it again made a near approach to Mercury, the orbit of which is exterior to part of that of the comet, and came within little more than three millions of miles of that planet. Some interesting observations were made during the appearance of that year, of which the most so were those of the late Professor W. C. Bond, at Cambridge, Massachusetts. We extract the following remarks from them, as published in the "Monthly Notices of the Royal Astronomical Society."*

"1848, August 27th. The comet is faint and without concentration; its light is coarsely granulated, so that, were it not for its motion, it might be mistaken for a group of very small stars.

"September 26th. A faint brush of light extends from the comet *towards* the Sun.

"October 6th. The comet is just visible to the naked eye. The brighter part is very eccentrically situated with reference to the general mass. A fan-shaped brush of light is very evident on the side *towards* the Sun. There is no other appendage which can be called a tail.

"October 27th. A faint ray of light is now seen directed *from* the Sun.

"November 3rd. The comet shows a tail of one or two degrees directed *from* the Sun; with the same appearance on the opposite side as in October."

We hope on some future occasion, but want of sufficient space now forbids, to have an opportunity of entering a little into the theories which have been started and discussed at various times to account for the phenomena presented by comets—remembering the truly just remark of M. Le Verrier, "It is well that views, which have even been hazarded on some points, should be brought forward concerning phenomena so complicated and hitherto unexplained; and provided attention be properly called to doubtful points in them, science cannot but gain by their discussion." That both attractive and repulsive forces are manifested between the Sun and comets is evident, and the oscillatory motion of the particles which are frequently seen to stream out from a comet towards the Sun, indicates the existence of a force of a polar character, as was many years ago remarked by Bessel. Study and observation will doubtless, as in so

* Vol. ix., p. 106.

many other instances, throw much additional light upon the appearances presented by these remarkable bodies. Spectrum analysis has here also been called in to our aid, and will be again when opportunities are afforded. Quite recently also the connection which identity of orbit between some comets and meteors appears to make probable, and the elaborate investigations into cometary systems (founded upon ideas which had suggested themselves to him) by Professor Hoek of Utrecht, have given hopes of leading to very interesting results. Laborious and persevering observation, readiness to examine any ideas which may be thereby suggested, and to abandon any idea as soon as it is shown to be inconsistent with facts, are necessary to all who would take a part in the advancement of science, and who desire to arrive at tenable conclusions in any of its departments.

THE MELBOURNE TELESCOPE.

The Committee on the Melbourne Telescope—Earl Rosse, Dr. Robinson, and Mr. Warren De La Rue—have just made a most favourable Report to the Royal Society on the construction and performance of this great instrument. There can, we apprehend, be no doubt that Mr. Grubb, of Dublin, has brought great ingenuity and skill to bear upon its construction and mounting, and that it is in many respects far more convenient and manageable than any other monster telescope hitherto made.

The Melbourne authorities took counsel with the Royal Society and—notwithstanding the merit of Mr. Grubb's performance—we shall be much surprised if they do not find reason for regretting that they were guided by the somewhat old-fashioned ideas which that learned body brought to bear on the solution of the question—"What sort of telescope shall it be?"

Metallic reflectors must now be considered as out of date. They are much more costly than the silvered glass mirrors introduced by Foucault, they reflect considerably less light, are much heavier, and, when their polish is lost, do not admit of reparation, except at a great expense, as the re-polishing is nothing short of re-figuring, which is a costly and delicate operation. Re-silvering a glass mirror costs little, and does not demand unusual skill.

The focal length desirable for a telescope depends upon its aperture, and as a larger aperture is required to get the same

amount of light from a metallic mirror, than from a silvered-glass one, it follows that the former will have a longer tube, with the inevitable result of additional vibration. It is mechanically impossible to make a long tube as steady as a shorter one; and although Mr. Grubb has evinced a high degree of skill in the mounting of his instrument, it is only necessary to inspect a photograph of it, in order to be convinced that a little wind must produce considerable motion. The point of suspension is near the mirror, on account of its immense weight, and in front of this point the telescope stretches forward to about thirty feet of open lattice tube-work, made of bands of elastic steel. The Royal Society's Committee give us no information as to the results of this arrangement, though it would be most important to know the actual amount of vibration produced by moderate air currents and changes of adjustment. In heavy winds, we presume, no one would expect a huge instrument to act well.

The telescope is on Cassegrain's plan, with the eye-piece, as in the Gregorians, at the bottom, and very convenient for use. The adjusting-apparatus, which is reported to work well, is brought close to the observer, and the mirror is stated to be very accurately and ingeniously suspended, as we might expect, from Mr. Grubb's reputation.

Practical opticians consider the Cassegranian form a very difficult one to make accurately; the curves of the large and small mirrors requiring the nicest mutual adaptation and adjustment. It would have been interesting to know, from experiment, whether this form, when the smaller mirror is at the end of a very long elastic steel lattice tube, suffers more derangement from vibration than a Newtonian does. It seems probable that such would be the case.

The telescope must be a fine one of its class, or it could not do anything like what the Committee report. They found "that the light even of large stars was collected into small, hard, and perfectly circular disks, free from rays, and though some diffused light surrounded them, it was exactly concentric with the central disks." In a note we are told that "the cause of this diffused light has since been discovered and removed." This would leave nothing but the clear hard disks to be seen, and as that is an optical impossibility, we presume the Committee either did not know of the insertion of this note, or were in a singularly approving frame of mind. There is nothing wonderful in the fact, "that the fifth and sixth stars of the trapezium in Orion were not only plainly seen,

but were very bright," in a telescope with a mirror four feet in diameter, nor that such an instrument showed ζ Orionis well; and even its splitting γ^2 Andromedæ with powers of 350 and 450 is not surprising, as the same feat has been performed with a With-Browning silvered-mirror telescope, $6\frac{1}{4}$ inches in diameter, and is not at all difficult, on good nights, for sizes a few inches larger of the same construction. The light-collecting power is stated to be very satisfactory. "The planetary nebula in 46 M. was revealed as a ring bright even as the dazzling ground of the surrounding stars, which were as brilliant as the Pleiades appear in ordinary instruments."

At present much interest is excited in the question of changes, or alleged changes, in nebulæ, and in minute details of planetary markings. For both these purposes extreme steadiness, as well as great optical power and accuracy, is necessary, and we shall wait with interest to know how far Mr. Grubb has succeeded in this very difficult but most important requisite.

We are glad to observe that Mr. De La Rue recommends that a photographic apparatus should be fitted to the telescope before it leaves Ireland.

A NEW ROTIFER WITHOUT CILIA—*BALATRO CALVUS.*

BY PROFESSOR ED. CLAPARÈDE.*

UNDER the name of *Apsilus lentiformis*, M. Mecznikow† has recently described a rotifer totally destitute of vibratory cilia. The absence of cilia in an animal of this description is almost new to science,‡ and worthy of attention. In fact, till lately, the existence of a vibratory apparatus has been considered by most authors as a characteristic indispensable to a rotifer. We cannot, however, hesitate to accept M. Mecznikow's decision in favour of classifying his genus *Apsilus* amongst the rotifers. Those who are doubtful would be convinced by an examination of the young individuals which he describes, for they at least do possess the cilia characteristic of this zoological group; and the absence of these organs amongst the adults can only be regarded as a case of repressive metamorphosis.

The publication of M. Mecznikow was less surprising to me than to many others; in fact, for several years I have been acquainted

* Translated from the "Annales des Sciences Naturelles"; sent by the author.

† "Zeitschrift Wissenchaft, Zoologie, 1866." Band xvi., p. 346.

‡ See last paragraph, where M. Claparède acknowledges Mr. Gosse's investigations of Taphrocampa, and those of Dujardin on Lindia.

with a rotifer entirely destitute of vibratile cilia. I did not describe it sooner, hoping to find opportunities for a more profound study of it. The animal is, however, not common, and the memoir of M. Mecznikow has induced me to refer to my old sketches.

The rotifer in question has nothing in common with the *Apsilus lentiformis*. I found it in the Seime, a little river in the canton of Geneva, where it crawled over the bodies of small Oligochætans. I gave it the name of *Balatro calvus*.* The animal is more or less vermiform. (Figs. 1 and 2.) Its body is very contractile and variable in all its outlines. The posterior extremity, corresponding with

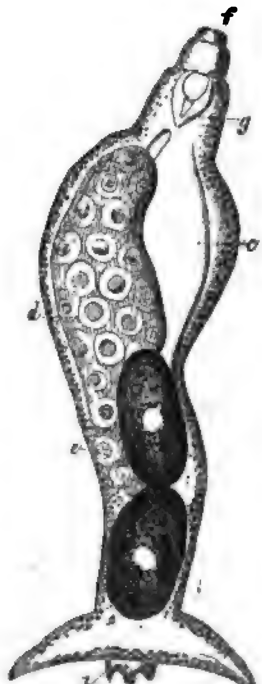

Fig. 1.

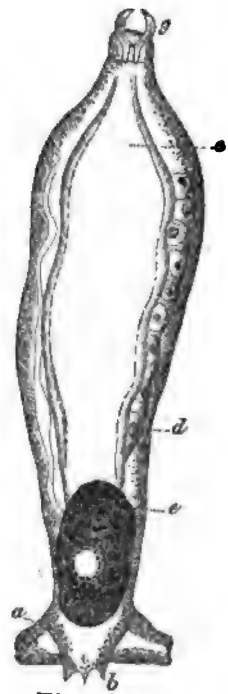

Fig. 2

what is called the foot of other rotifers, is divided into two lobes, one vertical the other dorsal. The first has a semi-lunar form. It has thus a convex side, a rectilinear side, and two angles. The rectilinear side is disposed transversely, and looks backward. The

* The parasite Balatro would no more leave Mæcenas than his shadow. In like manner this rotifer will not leave the bodies of the Oligochætans:

Summus ego, et prope me Viscus Thurinus et infra
Si memini Varius, cum Servilio Balatrone
Vibidius, quos Mæcenas adduxerat umbras.—Hor.

two angles are very acute, and can be retracted, invaginating themselves like the finger of a glove pushed inwards. (Fig. 2 *a*.) The upper lobe is a flattened cylindrical process, terminated by thin, small projections. The anus is situated between the two lobes.

The anterior extremity of *Balatro calvus*, vaguely annulated, is susceptible of retraction into the interior of the creature, as in other rotifers. By its transparency we then see the mastax relatively feebly developed, armed with a very small incus, and two hooked mallei. It opens directly into an intestine with thick walls, the internal layer of which is of a brown colour. The digestive tube is more simple than in most other rotifers, it extends in a straight line from the mouth to the anus. The anterior portion, a little narrower than the rest, scarcely deserves the name of an œsophagus. I have seen no traces of the glands so usually annexed to the stomachs of creatures of this class. When the animal stretches itself out, and protrudes its proboscis, the curved jaws project beyond the body. There are not even rudiments of cilia to be seen in the region of their proboscis.

All the individuals I observed were females. The ovary occupied the ventral side of the body, below the intestine (Fig. 1). The ripe eggs are ovoid, and lie at the posterior end of the body. Is there a system of secretory canals? I am not quite certain of this matter. I have not studied the nervous or muscular systems. There is no eye spot or antenna.

Genus Balatro. Rotifer with vermiform body, very contractile; posterior extremity terminating in two lobes, one ventral, semi-lunar, and transverse; the other, dorsal, approximately cylindrical, acting as a foot, mallei hooked, no vibratile organs, no eyes. Species: *Balatro calvus*, Clprd., habitat, the Seime, canton of Geneva, crawling upon mud-inhabiting Oligochætæ.

M. Claparède remarks, that Mr. Gosse had, long before these observations, or those of M. Mecznikow, described Taphrocampa, a rotifer without vibratile cilia. He objects to Mr. Gosse's recent classification of this genus amongst the *Gastrotricha Chetonotidæ*, or "hairy-backed animalcules." Dujardin had, previous to Mr. Gosse, described his Lindia as a rotifer without cilia.

DESCRIPTION OF CUTS.

Fig. 1.—*Balatro calvus* in supination. *a*, inferior caudal lobe (semi-lunar); *b*, upper caudal lobe; *c*, digestive tube; *d*, ovary; *e*, ripe eggs; *f*, mouth; *g*, jaws.

Fig. 2.—The same in pronation, similarly lettered.

CORRESPONDENCE.

INDIAN LEPIDOPTERA.

(*To the Editor of* THE STUDENT.)

IN Drew Drury's "Exotic Insects," vol. i., plate xxiv., p. 45, a singularly beautiful Nocturna, of the family Bombycidæ, is described under the generic and specific name of *Actias luna* (synonym *Phalæna* (*Attacus*) *luna*), of which he gives the following diagnosis :—"Upper side : antennæ brown and strongly pectinated, the head white, small, and almost hid under the shoulders and neck, having a small brown ring encircling it; thorax pale yellow, having a chocolate or dark brown line crossing it, parallel with the margins of the anterior wings. All the wings are of a beautiful pea-green colour, the nerves being of a pale red-brown. Along the anterior margin of the anterior wings runs a chocolate line, which is narrowed towards the tips. About an inch from the shoulders springs, from this line, a small curved one, which, bending towards the middle of the wing, terminates in a small eye, pointed in the lower part, whose pupil is transparent, like glass; the iris being partly red and partly black, within which are semicircles of white. External margin of the wings red-brown, the posterior being white. Posterior wings furnished with two broad tails, which at their extremities appear as if they were crimped, their external edges being red-brown; in the middle of each of these wings is likewise an eye, similar to, but rather larger than, those in the anterior ones. Abdomen white. Under side : abdomen white, the sides being of a dark clay colour; wings of the same colour as on the upper side, the nerves being brown and more conspicuous, without the brown edge on the anterior pair; the eyes same as above. Anterior margin of the inferior wings is white, and the eyes strongly resemble those of an animal having them half shut." Drury's correspondent informed him that the caterpillar of this handsome moth is red, and feeds on the leaves of the Sassafras tree. When they are full fed, they enclose themselves in a strong case composed of the substance of the tree and a glutinous matter, which they secrete. The caterpillar, however, figured by Abbot is green, with short hairs scattered over the body, and with about eight small red spots on each segment, placed transversely. So much from my edition of Drew Drury's work, which assigns the habitat as "New York, Carolina, Virginia, Maryland." In reading Sir Emerson Tennent's "Natural History of Ceylon," I found a moth described which seemed to approach very nearly to the description given above, and have since had the good fortune to take two very magnificent specimens on the continent of India, differing slightly, but markedly, from the North-American species of *Actias*. The first I found in a hedge at Coonoor, on the Nilgherri Hills, in the month of August; the second on a tree in my

garden at Kampti, in Central India, about the same time of the year. Both were very sluggish and dull, allowing themselves to be taken without an attempt to fly. The second one was so full of large eggs (which I dissected out), that they were bursting through a fistular opening in the side of the abdomen. I am induced to give you this account, because, finding them at so great a distance apart, and both in the hill region and in the plains of India, I should conclude that they are widely diffused over the country; and yet, though I have shown them to several intellectual observers of nature, and to two or three industrious collectors, they do not appear to be generally known, so that I conclude they are nowhere very abundant. The general shape, the curious long, broad crimped tails to the posterior wings, and the beautifully delicate pea-green colour of my specimens, correspond with what Drury describes, and very closely with what he figures, with the following exceptions—the strongly pectinated antennæ are a *very* pale brown; there is no yellow on the thorax, but thorax, abdomen, and the inner margin of the wings are densely covered with a pure white silky down; the brown madder markings over the veins are very faint and little seen, except with a very oblique light. The bent line leading from the margin of the wing to the eye on the anterior pair is also entirely absent; but a narrow faint line of slightly deeper colour runs all round the external edge of the rings, about a quarter of an inch from the margin. One of my specimens measures six and a quarter inches from tip to tip of the expanded wings, and four and a half inches from the head to the extremity of the broad tails of the posterior wings; the legs are strong, and of a reddish madder brown colour; eyes large, black, and rather prominent. The specimen that I took on the Nilgherri Hills was on a bush of *Symplocos nervosa;* the one that I took in the plains was on a small tree of *Ægle marmelos.* But this, perhaps, says nothing as to the food of the larva, except that the one last mentioned seemed ready to deposit her eggs. I have not had the good fortune to discover the caterpillar, or, to my knowledge, the cocoon; unless I can attribute to this insect some very large ones which I saw (but all abandoned) some years ago in the jungles in Coorg. Drury's remark upon the resemblance of the ocellated spots on the wings to the half-shut eyes of an animal, applies very well to these East Indian specimens.—JOHN E. HALLIDAY, Lieutenant-Colonel.

[Col. Halliday's insect and the closely allied American species to which he refers, now belong to Hübner's genus *Tropæa.* The Indian species is *T. Selene,* Hübner (Verz. Schmett., 152, 1588), described and figured by McLeay, under the name of *Actias Selene,* in Leach's Zool. Misc., ii., pl. 70. The larva is described and figured by Hutton, in Trans. Ent. Soc. Lond., v., 45, pl. 5, fig. 11. The insect, which is very variable in size, appears to be not uncommon, and to be widely distributed, occurring at Nepaul, Silhet, North China, Ceylon and Java (Dr. Horsfield).—ED.]

PROGRESS OF INVENTION.

LIFE BUOYS.—It is a slow and troublesome process to blow up an ordinary life buoy, and one can easily understand the difficulty which would be experienced in doing it when under the influence of fear from danger of drowning and sudden and unexpected immersion in water. To render a life buoy self-inflating is therefore most desirable, and Mr. J. S. Hood has succeeded in doing so. The buoy is made of india-rubber, or some such air-tight elastic material (he prefers to use vulcanized india-rubber), its shape is annular, and in its ordinary state it would be expanded and full of air; when not required for use, the air is to be pressed out, and the stop-cock, with which it is supplied at its neck, closed. In this condition it can be worn round the person, and when desired, by opening the stop-cock, the elastic sides expand and the vessel becomes filled with air. Nettings are in some cases fixed round the edge of the buoy, thereby enabling others to save themselves, as well as the person wearing it.

METHOD OF PRESERVING MEAT.—To destroy animal germs in meat, Mr. Theophilus Redwood heats it in parafine in a strong vessel, with an air-tight cover securely fastened down, raising it to 270° or 280° F.; he keeps it at that temperature for about half an hour, the juices being confined, and the steam generated, assist in raising the temperature; after this it is allowed to cool gradually. To cause a more perfect exclusion of air, he adds to the parafine coating, which is liable to crack or peel off, another, of a transparent material, which will allow of the meat being seen through it; this coating is made of gelatine, to which he adds sugar or glycerine, or even both if required, in such proportions that when dried it may be flexible and elastic. The proportions in which he uses these substances are as follows: six pounds of gelatine, in from twelve to fifteen pounds of water, dissolved by heat in a water bath, and two pounds of glycerine, or one pound of glycerine and one of sugar or gum is added. The mixture, thus prepared, is to be applied while fluid by heat; but not so hot as to melt the parafine which has been previously applied.

PREPARING AND PRESERVING STYPTIC PAPER.—M. Gustave Gabillon, of Paris, has discovered a method to render more effectual and convenient of application, and, at the same time, preserve the hæmastatic properties of perchloride of iron, or, as it is sometimes called, muriate of iron. It is well known that this substance possesses these properties in a high degree, and paper, or any tissue prepared with it, instantly stops bleeding when applied to wounds. It is inconvenient to carry about the solution of ferric chloride, nor is it easy to apply it. M. Gabillon's invention consists in his method of making and preserving the paper. He first dries, and then coats the paper or other tissue used with a protecting composition, to prevent its destruction by the perchloride of iron. The method

of application is as follows: the paper is first dipped in a solution made of one pound of gum benzoin of the first quality, one pound of rock alum, four and a third gallons of water; this mixture is heated in a vessel, carefully tinned inside, up to the boiling point, and the solution is to be kept boiling for four hours, and skimmed from time to time. The water evaporated is to be replaced by the same quantity of fresh water, and, as soon as the solution has cooled, it is to be filtered off. The paper or tissue is then to be dipped into it, and to be kept there till sufficiently saturated; it is then to be carefully dried. When dry, a solution of perchloride, in a more or less concentrated state, is applied by a brush or roller. The paper or tissue thus prepared is folded up and preserved from the action of the air by wrapping it in a piece of waterproof taffeta, prepared with the addition of resinous substances, and in this manner it can be preserved any length of time in a state always ready for use.

Treatment of Nitro-Glycerine by M. Alfred Nobe of Paris.—If nitro-glycerine be mixed with inexplosive porous substances, such, for instance, as charcoal or silica, it becomes very much altered in its properties. Thus, for example, nitro-glycerine alone is not inflammable by a spark, but may be made to explode by submitting it to the rapid action of a shower of sparks. Nitro-glycerine absorbed by porous substances easily catches fire from a spark, but burns away slowly, and without explosion, except it be kept in close confinement, in which case it explodes violently. The above mixture is also less sensitive to shocks and blows than nitro-glycerine by itself. Owing to its peculiar properties, this mixture, in blasting sound rocks, requires only the ordinary safety fuse; but in shattered rocks, or coal, it will cause no real explosion at all, as the gas will leak out through the crevices; for this reason a special igniter is used to explode it in fissured rock, or wherever it is not in *close* confinement, and this special igniter consists of a kind of percussion cap, in which the fulminate is caused to develope a very high gaseous pressure before it bursts, which may be attained either by increasing the charge of the fulminate, or diminishing the leakage of the gas before the cap bursts; this cap is adapted to the end of a safety fuse, by which it is ignited.

Improvements in Fire-Grates.—Some time ago it was recommended to place an iron plate at the bottom of a fire-grate, to light the fire from the top, and to leave it undisturbed. Many who tried the experiment found it to answer tolerably well, and that, by it, considerable saving of coal was effected. There is, however, this objection, that the kindling of the fire is slow, and that when a brisk fire is desired it cannot be obtained, for by poking the very opposite effect is produced. Mr. J. McOwen, of Rochdale, has patented a new grate, which seems to possess all the advantages and none of the disadvantages attending the use of the iron plate. He makes a box, on the top of which is a fine grate for the fire to

rest upon, and at the bottom is a coarse grate; in the box between the grates a sliding valve is placed, which can be opened or closed at pleasure; by this means the supply of air to the fire can be regulated by opening or closing the valve, and in this manner the quantity of coal consumed in a given time can be regulated, and so the fire can be made bright or dull at pleasure.

Manufacture of Iron and Steel.—Mr. Richardson, of Glasgow, has invented and patented a process for burning out the carbon from the crude metal. It consists in the introduction of a current of atmospheric air, introduced into the molten crude metal. When the ore is reduced in the blast-furnace, it is run off into a proper vessel; a blast of air at a pressure of four pounds on the square inch or upwards is introduced into the melted mass, through a hollow rabble or stirring-rod of a size suited to the mass to be decarbonated. The effect is that the impurities are rapidly driven off, and the metal obtained is specially adapted for producing castings of high quality. It may be run into moulds immediately after purification, or it may be cooled and afterwards melted for casting, and for this purpose it may be used alone, or with a portion of pig-iron or spiegel-eisen, or with any other compound of carbon and iron, which may be mixed with it in the molten or solid state, according to the temperature of the liquid metal in the receptacle. Crude steel may also be produced by the same process, and to get a finer steel, after the metal has been purified in the manner described, it may be run off into a chamber of a puddling-furnace, where unmelted spiegel-eisen or other compound of iron and carbon is added to it, to recarbonize the metal and so convert it into steel, which may be run off into ingot moulds. To insure thorough admixture of the carbonized compound with the purified melted metal, the charge is stirred up in the puddling-chamber with an ordinary rabble, and if desired powdered manganese, or other oxidizing compound, may be added through a tubular rabble previous to the addition of the carbonized compound of iron. If desired, steam may be used as the oxidizing agent.

A New Stopple for Soda-Water Bottles.—A very ingenious and useful stopple for soda-water bottles has been patented in America. It is much more simple, and less likely to get out of order, than the piston, and seems calculated to be quite as efficient, where it is required to take portions of soda-water from a bottle without allowing the carbonic acid to escape from the remainder. It consists of a globe of india-rubber, with a hole through its axis, the orifices being protected from wear by metal eyelets. Round the neck of the bottle is twisted a wire spring, which is passed through the india-rubber sphere, and keeps it in position over the mouth of the bottle, which it effectually stops. By the pressure of the thumb on the side of the stopple it can be pushed aside to allow the liquid to pass out; on removing the pressure it immediately returns to its place, the tension of the spring keeping it firmly fixed.

BOTTLES HERMETICALLY SEALED.—Gelatine mixed with glycerine yields a compound, liquid when hot, but becoming solid on cooling, at the same time retaining much elasticity. Bottles may be hermetically sealed by dipping their necks into the liquid mixture, and repeating the operation until the cap attains any thickness required.

DR. BRUNETTI, of Padua, who obtained the gold medal at the Paris Exhibition, has given a description of his process for preserving anatomical specimens to the International Medical Congress. It comprises four operations, viz.: 1st, the washing of the piece to be preserved; 2nd, the dégraissage, or eating away of the fatty matter; 3rd, the tanning; and 4th, the desiccation. 1. To wash the piece, water is passed through the blood-vessels and the various excretory canals, and the water is washed out by alcohol. 2. For destroying the fatty matter, ether is passed through the same vessels; this part of the operation lasts for some hours. The ether penetrates the interstices of the flesh, and dissolves all the fat. The piece at this point of the process may be preserved any length of time desired, kept in ether, before proceeding to the final operations. 3. For the tanning process, tannin is dissolved in boiling distilled water, and is then, after washing out the ether, injected into the vessels and tissues. 4. For the drying process, Dr. Brunetti places the pieces in a vase with a double bottom, filled with boiling water, and he fills the places of the preceding liquids with warm dry air. The air is dried by passing it over chloride of calcium, it is then passed through a heated chamber, and from thence through the vessels and ducts of the specimen, the air being dried and heated, and forced into the preparation under a pressure of two atmospheres. In this way he gets rid of all moisture in a very short time. After this treatment the piece remains supple, light, preserves its size, its normal relations, and its solid elements. It may be handled without fear, and will last for a very long time.

A NEW METHOD OF PREPARING TARTARIC ACID.—Tartaric acid is ordinarily prepared from a substance called argol, which is deposited at the bottom of wine-vats, and is, from the scarcity of the material, of considerable value. On account of this, Juette et De Pontéves made a series of experiments on the skins of grapes, which have up to this time been used only as manure. His method of preparing tartaric acid is as follows:—He boils the skins with two per cent. of sulphuric acid for some hours; this changes the sugar and part of the cellulose into grape sugar, and sets free the tartaric acid. After fermentation, a considerable quantity of spirit is obtained by distillation, and the tartaric acid is precipitated as a lime salt, from which it is set free by the action of sulphuric acid.

PREPARATION OF VARNISHES WITH TAR.—Varnishes, made according to the process discovered by Dr. G. Lunge, are especially useful for preserving iron; they are of different kinds, and adapted either to rough or highly-finished iron-work. Dr. Lunge melts pitch in an iron vessel;

when it is cold, but still fluid, he adds heavy tar oil; the whole being thoroughly mixed. The necessary quantities are easily found by practice. This varnish, which is as cheap as common tar, will dry in one or two days. For preparing a quicker drying varnish, a quantity of tar-oil of a higher boiling point is added to the melted and cooled pitch. Fine castings or ornamental wrought iron-work, may be varnished with a mixture made in the same way, in which naphtha is substituted for the heavy tar oils. This varnish will dry in a quarter or half an hour. These varnishes are much better than common tar, which contains ammonia, and, when applied cold, causes oxidation; they also possess greater power of penetration than boiled tar, and are therefore better adapted to wood or absorbent substances.

PARAFFINE AS A LUBRICATOR FOR MACHINERY, EXPOSED TO A HIGH TEMPERATURE.—A sort of paraffine, which becomes soft at 15° to 20° C., can be obtained at a low price; it is soluble in fat oil, insoluble in water, and can be distilled without decomposition at 370° C. The advantages of its application to machinery are as follows:—While the machine is in action the paraffine is very fluid, and flows easily; any of it which may be carried away by water-vapour will be found, when cold, in lumps in the upper part of the condenser, from which it can easily be collected and removed. When the machine is not in action, the paraffine hardens, and does not run and drip as the oil in general use; as soon as the engine is set to work, the heat evolved will render it sufficiently fluid.

ETHYLANILINE GREEN.—J. Keisser, of Lyons, has prepared from ethylaniline a green, which is considered to be a salt of picric acid. He dissolves Hofmann's blue in three parts of spirit, and adds to it half its quantity of iodide of ethyl. After heating for half an hour in a closed vessel, one or two parts of caustic potash are added, the whole being heated for two or three hours. The pasty residue which is produced being tricthylrosaniline, is carefully washed, and the iodine is recovered from the wash water. The residue is then boiled with four or five hundred parts of water, in which it is dissolved. It is then mixed with a concentrated solution of picric acid. After standing for twenty-four hours, a green substance will crystallize out, which can be used as a dye in the same manner as other aniline colours.

MANUFACTURING EXTRACT AND ESSENCE OF HOPS.—Theophile Auguste Breithaupt of Paris has invented a process for this purpose. The hop extract is a dark brownish product which may present itself under three forms; first dry and pulverulent, second soft and thick, third liquid: it has a bitter taste, is partly soluble in hot water, and partly in alcohol, and serves to give the bitter taste to beers. It is preferable, as being cheaper, to crystals (the other form in which the bitter principle of the hops might be presented to the brewer). The essence of hops is a volatile liquid of a clear green or yellowish colour, soluble in alcohol, and serving to give the aroma to all kinds of beer when used in their

manufacture, either before or after fermentation. These two products are extracted from the cultivated or from the wild hop. The first is contained in various parts of the plant, especially in the follicles of the bind and in the pollen; the second, that is the essence, is contained only in the pollen. These products therefore contain in a very small bulk, the active principle of the plant, they keep perfectly well, and may therefore be prepared in seasons when hops are plentiful. In carriage and packing the hop loses much of its pollen, and two-thirds of its essence by dessication. M. Breithaupt operates directly on the fresh plant, in order to get out the greatest possible quantity of extract as well as essence. The essential oil is brought out by distillation in a steam bath and collected in a Florentine receiver. The extract is prepared by displacement, first in boiling water, and afterwards in alcohol, and by evaporating the charged liquids to dryness; after filtration the alcohol employed is recovered by distillation to serve a second time. The essence is more rapidly got out than the extract. In order to act on the fresh plant without losing time, it may be submitted firstly to distillation, and then dried to preserve it until the time when it is convenient to make the extract.

To Preserve Iron from Oxidation.—Hector Auguste Dufrené, of Paris, proposes to preserve iron from oxidation by coating its surface with brass. For this purpose he employs a salt of copper or oxide of copper which he dissolves in borax (biborate of soda). To this solution he adds a salt of zinc, and then dips the articles to be coated into the bath thus prepared, and passes an electric current through the metal and into the solution, so as to stimulate the deposit of the alloy of copper and zinc on the iron. When electricity is not employed, the iron after being well scoured can be dipped into a solution of borax, then into a bath of melted copper, either pure or alloyed with zinc or tin. These processes are applicable to steel and cast iron.

Sugar Refining.—Mr. J. H. Johnson has taken out a patent for refining sugar in the following manner. Crude sugar is first cleared of pieces of stone and such impurities, it is then reduced to a homogenous condition by passing it through rollers or by any other suitable treatment; it is then mixed in a proper vessel by machinery and moistened with water until it assumes a pasty consistence, when it is placed in a centrifugal machine, larger than is ordinarily used. The machine being set in motion the first solution is thrown off, this being derived from the sugar, dissolved by the preliminary moistening, consists of impurities, which coated the sugar, as well as of a sugar solution; after this first stage of the process, the solution is conveyed to a suitable tank; water and steam are applied by sprinkling and in jets to the sugar within the centrifugal machine, and another solution is thrown off, and is conducted to a separate tank from the first; thus the process may be continued, stage after stage, until the sugar is entirely dissolved, care

being taken to keep the different solutions separate. Of the solutions obtained, the first is the worst, the last the best. The process also applies to melado and molasses, after it has been granulated, and when it is desired to re-dissolve it.

ARCHÆOLOGIA.

Mr. Gordon M. Hills, the treasurer of the British Archæological Association, has made some interesting discoveries of Roman remains at West Hampnett, in Sussex. The church of West Hampnett is about two miles from Chichester, and stands on the side of the Roman road which led from the east gate of that city (the Roman *Regnum*) to London, and which is still the public highway to the metropolis in this part of the road. In the course of last year the church was being enlarged, and the chancel was repaired. The building had hitherto consisted of a chancel and a nave with a south aisle. No work of older date than the thirteenth century was apparent in the chancel, all the older windows of which, externally, belonged to that period. Internally, all architectural character was concealed by a modern application of battens and lath and plaster over the entire walls and window jambs. The roof was modern, and of the meanest description. The nave and south aisle were chiefly of early thirteenth century work, but the north wall of the nave had been in great part rebuilt in the fifteenth century, the door and windows being of that late date. Mr. Hills was engaged to direct the enlargement of this church, which was effected by taking down this north wall of the nave, and raising in its place an arcade for an additional north aisle. In taking down this north wall, a few pieces of Roman tile were found among the rubble work. It was in the chancel, however, that the most interesting discoveries of Roman and Saxon remains were made, and these were of very considerable importance. The chancel arch was formed a plain semicircle, without chamfer or moulding, the jambs having rude stone dressings, and the archivault being faced with modern plaster. The width of the opening was less than six feet; it was low, and yet bore appearances of a rude attempt at some period to enlarge it from some still smaller dimensions. When the modern plaster was stripped off, the arch was found to be entirely constructed of Roman tiles, taken no doubt from some earlier Roman building. Many of these tiles were perfect, but the greater number had been broken when used by the ecclesiastical builders. They were, when perfect,

of two sizes, one about eighteen inches by ten or eleven, the other twenty-two inches by fourteen, and respectively one and a half and two inches thick. Upon stripping off both the inside and outside plaster of the side walls of the church, unmistakable characteristics of Saxon work with Roman materials presented themselves. The western part of the chancel, both in its north and south walls, in rather more than half its length, was found to be built of rubble stone and flint, largely mixed with broken Roman tiles of the same kind as those used in the chancel arch, the work being in herring-bone courses. In each of these side walls a small rude Saxon window still remains, though blocked up. The head of the window in the north wall has been broken away, but like that of the other, which still remains, it was no doubt a little semicircular arch cut in one stone. Except the external heads, neither window ever had any cut stone, nor was there any provision for glazing. Internally the windows splay out to a good width, and have semicircular arches of rubble. Besides the flat Roman tiles, these side walls contain fragments of Roman roofing tiles (*imbrices*), and some fragments as well as perfect examples of Roman tiles of a very unusual description, evidently designed for some kind of arch work. Each tile is a perfect voussoir of an arch, and is hollow, as if intended for a flue-tile. Mr. Hills, however, thinks that these tiles were made hollow only to secure greater perfection in their manufacture. Among the Roman *debris* were found two pieces of marble, probably from the neighbourhood of Torquay, in Devonshire. They were small squares, which had originally been used in a pavement, and were much worn by the feet of those who had walked over it.

The chancel arch, and the whole east end of the nave in which it was placed, were evidently part of a Saxon nave, in form a simple parallelogram, and the Saxon side walls of the present chancel indicated the extent of the Saxon chancel. In the thirteenth century, the east end of the Saxon chancel was taken down, the chancel was increased in length, the new work being totally different in character from the older part, but the material of the east Saxon wall, with its Roman *debris*, was used in the lower part of the extension of the north wall. Four lancet windows were inserted in the old Saxon work, and a fifth, with an elegant piscina underneath, was introduced in the extension of the south wall. The new east end was furnished with a good window of two lancets, with a quatrefoil in the tympanum of the arch which coupled the lancets together.

In the restoration of the chancel, which has now been effected, the whole of the ancient work, whether Roman, Saxon, or of the

thirteenth century, has been preserved, and left open to view, with the exception of the chancel arch, which has been necessarily enlarged.

In laying these discoveries before the British Archæological Association, at one of its recent meetings, Mr. Hills remarked that the CHURCH OF RUMBOLDSWYKE, about a mile distant from West Hampnett, was undoubtedly Saxon, and had Roman tiles in herring-bone courses in the east end of the nave. The county of Sussex is remarkable for the number of its Anglo-Saxon ecclesiastical remains, the preservation of which we probably owe to the respect which its population cherished towards Wilfred, who converted them to Christianity in the latter part of the seventh century. Mr. Hills considers that the church of East Lavant, about a mile and a half from West Hampnett, in another direction, though free from Roman remains, is also a Saxon church.

T. W.

LITERARY NOTICES.

PHYSICAL, HISTORICAL, AND MILITARY GEOGRAPHY. From the French of Th. Lavallée, late Professor of Military History and Statistics at the Military School of St. Cyr. Edited, with additions and corrections, by Captain Lendy, F.G.S., F.L.S., Director of the Practical Military College at Sunbury. (Stanford.)—The old plan of teaching geography, as a tiresome catalogue of places, latitudes, longitudes, etc., no doubt lingers in thousands of bad schools, but has long been exploded in good ones. To Humboldt, Rittor, and Steffens belong the chief merit of creating a science of physical geography; and it is too much for Mr. Lendy to say that in 1836 Lavallée opened a new era in its study. The edition of Lavallée's work which he now brings before the public in an English guise, is, however, a very useful book, and would have been more so if the translator had been more careful to correct its errors, and bring it down to date.

In the first page, the mean distance of the sun from the earth is given as ninety-five millions of miles, though well-known recent determinations make it less. The second paragraph contains exploded notions which no "F.G.S." should have passed in silence. Lavallée states that the earth "may be said to be divided into two parts, the central nucleus or interior part, whose radius is probably upwards of 3480 miles," and the "external crust or superficial part, which has a variable thickness of not more than twelve to twenty-four miles." The interior part, we are then told, "the most recent researches have almost demonstrated to be composed of

incandescent matters." How Captain Lendy, with any pretensions to acquaintance with recent science, can have allowed this totally erroneous assertion to stand we cannot conceive. Recent researches, from those of Hopkins downwards, have all concurred in showing that our earth cannot possibly be a thin bottle containing an immense body of incandescent matter. The "facts" adduced in proof of the exploded theory are, first, "the density of the earth, which is so great, that its interior must consist of very much heavier matters than those composing the external crust." Now it is absurd to assume the incandescence of the interior part from the necessity of its containing heavy matters; and it is illogical to add, as a second "proof," the assertion of the existence of a "central heat proper to the earth." Such heat may exist, but it is not positively known, or positively evidenced by the fact that temperature augments in the course of the trifling distances to which man has descended. The third "proof" of central incandescence is drawn from volcanic phenomena, which Mallet's researches have shown not to be very deeply seated.

In another paragraph we are told that the exploration of the substances composing a mountain 24,000 feet high, is equivalent to that of a plane to the depth of 2400 feet. This could only be true if the plane strata were all horizontal, and the mountain was formed by the elevation of a mass of strata, 24,000 feet thick, with a perfect preservation of their horizontal position. M. Lavallée affirms that the "whole crust of the earth shows marks of sudden and numerous revolutions." Mr. Lendy has modified this in a note, but he has omitted to correct the serious error of representing all the so-called "primary rocks" of the older geologists as having "resulted from the first solidification of the earth." There is no reason whatever for supposing that any human being has seen a particle of matter in the state left by the earth's first solidification, and igneous rocks belong to a variety of dates. This geological chapter does not contain a single paragraph that represents the existing state of science. It should have been entirely re-written or left out. The chapter on physical geography is very unsatisfactory. Mountains are divided, according to their heights, into four orders, and they are arbitrarily stated to have four, three, and two regions. Those, for example, which are from four to nine thousand feet high, "contain," we are told, "only three regions, cultivated, forest, and pasturage," while those which are at least 11,500 feet, have "four regions," the three just mentioned, and one of perpetual snow; and those less than 4000 feet, have only two regions, cultivated and forest." Now it would be impossible to crowd more errors into a few lines. Turning to the work of a cautious writer, Prof. Ansted,* we find the limits of perpetual snow in the Andes of Peru stated to be 18,000 feet, while in the Straits of Magellan it is only 3,390 feet, and close to the Arctic ocean 2,000 feet. In another passage we are informed

* "Physical Geography."

that "in high mountains, spaces are met with where there is permanent congelation: these are glaciers." It is certainly not a sound definition of a glacier to call it "a space of permanent congelation," nor is it true that glaciers are always found where permanent congelation exists.

Following the chapter on physical geography, is one on "Man considered by Himself," and another on "Man considered Socially," neither of which can be commended. In the latter we are informed that "the *revenue* of a State is the sum of the *taxes* required to liquidate its expenses," a doctrine which would be fatal to even the possible existence of a national debt.

The parts we have criticised bear a very small proportion to the whole work, but we fear they will materially restrict its use, though it would be well to consider them omitted, and to regard the treatise as commencing where they end. The useful part of the work begins at p. 58, with the description of the Spanish region, then follow the French region, the German region, the Italian region, the Greek region, the British region, after which came descriptions of Asiatic, African, and American regions. These are in the main very well done, and upon a plan likely to be very useful to military men. As a whole, we must speak of this book favourably, and our objections to its early chapters must not be regarded as involving any general condemnation. If those chapters interfere, as we expect they may, with its introduction into schools, the general merits of the book would make it desirable to arrange a fresh issue in which they might be entirely recast.

A School Manual of Health. Being an Introduction to the Elementary Principles of Physiology. By Edwin Lankester, M.D., F.R.S. (Groombridge and Sons.)—Dr. Lankester has in this small, nicely printed, and cheap volume, supplied a work adapted to "the elder scholars in national and other schools." It consists of seven chapters, beginning with the Constitution of the Human Body; then treating of Food, Digestion, Respiration, Structure and Functions of the Skin, the Movements of the Human Body, the Brain, Nerves, and the Organs of the Senses. Used, as Dr. Lankester recommends, with the large diagrams he mentions, it would prove an efficient and interesting class book, and the subjects of which it treats, ought most assuredly to be generally taught.

Half-hours with the Telescope; being a Popular Guide to the Use of the Telescope as a means of Amusement and Instruction. By Richard A. Proctor, M.A., F.R.S., with illustrations on stone and wood. (Hardwicke.)—Mr. Proctor's handy and cheap little volume is addressed to a class of observers wanting more elementary aid than those for whom Mr. Webb has so ably provided. After a preliminary chapter on the construction of telescopes, the constellations are arranged in groups, which can be conveniently examined at the same time of the year, or on the same evening. Several well-designed maps are supplied to assist in

recognizing the various objects, and numerous illustrations are given of double stars and nebulæ, the angles of position of the former being indicated by arrows representing the apparent paths of the stars across the field of the telescope. Following the star portion of the book, come half-hours with the planets, with two plates, one giving elaborate details of the various aspects of Mars, besides diagrams of Venus and Mercury. Half-hours with the Sun and Moon wind up the work. All through we notice evidence of Mr. Proctor's skill in condensing information, and making difficult matters intelligible. At p. 78, for example, is an ingenious method of finding Mercury by means of crossed sticks easily set up.

Recollections of the Paris Exhibition of 1867. By Eugene Rimmel, Member of the Society of Arts, the Royal Horticultural Society, the Nice Horticultural Society; Juror and Reporter, Exhibition, 1862; Assistant Commissioner, Exhibition, 1867; Author of the "Book of Perfume," etc. (Chapman and Hall.)—A series of articles on the French Exhibition, written by Mr. Rimmel for the "Courier de l'Europe" and the "Patrie," richly illustrated by engravings from the "Art Journal," and now translated into English, makes a very elegant and useful *souvenir* of the great show at Paris. As a book for the drawing-room table, and supplying a valuable collection of ornamental designs, this pretty work cannot fail to be appreciated. Mr. Rimmel's remarks on the various objects indicate fairness, and good taste.

Summary Notes on Vegetable Anatomy and Physiology, and the Classification of British Plants. By Louis C. Miall, Curator to the Philosophical Society, Bradford. (Simkin, Marshall, and Co.)—This is a thin pamphlet with four plates, in which the author has endeavoured to compress a great deal of matter. A little publication of the kind would, we apprehend, be most useful to a class taught, according to a method which it would illustrate. For private study it seem too meagre to be satisfactory.

On the Principles of Grammar. By the Rev. E. Thring, M.A., Head Master of Uppingham School, Oxford. (Clarendon Press, Macmillan and Co.)—In the hands of a good teacher, this grammar would be an efficient instrument of instruction. The illustrations from various writers would easily make the study interesting, instead of being, as it usually is, a bore to young people, and the explanations are lucidly given.

Practical Water-Farming. By William Peard, M.D., LL.B. (Edmonstone and Douglas.)—Dr. Peard has written a pleasant book on the artificial culture of fish, lobsters, crabs, etc. He is very sanguine of the commercial success of water-farming, and in addition to descriptions of well-known experiments, he adduces many others to which little or no attention has hitherto been paid. It is certainly strange that this country should have so long neglected sources of profit which the Dutch, Italians, French, and Germans devote much attention to. The high price of

butcher's meat, and the increase of population, renders it highly important to make the most we can of water-farming, and Ireland offers many facilities for the work. Dr. Peard would turn all sorts of localities to account, and he contends that where clay exists for puddling, three acres of poor land converted into ponds may be made to yield £200 per annum in pike, perch, and eels.

A Key containing Answers to the Exercises in Galloway's First Step in Chemistry. (Churchill.)—Students using Galloway's "First Step in Chemistry" will be glad to know that this key to its questions is published in a convenient form. It contains seventy-eight pages of well-arranged matter.

Bible Animals: An Account of the various Birds, Beasts, Fishes, and other Animals mentioned in the Holy Scriptures. By the Rev. J. G. Wood, M.A., F.L.S., Author of "Homes without Hands," etc., copiously illustrated with new and original designs, made under the author's superintendence, by F. W. Keyl, T. W. Wood, and E. A. Smith, and engraved on wood by George Pearson. (Longmans.)—This popular and deserving work maintains the interest of its earlier numbers. It is an excellent family book, and will be in constant requisition amongst Bible readers of all ages.

The Rudiments of Mineralogy: a Concise View of the General Properties of Minerals. By Alexander Ramsay, junior, with Copious Index. (Virtue and Co.)—This seems to be a useful compilation of 330 pages. The author states that it is chiefly founded on Rammelsberg's "Mineralchemie," De la Fosse's "Mineralogie," Bischof's "Chemical and Physical Geology," and Der Cloiseaux's "Mineralogie." The arrangement of the minerals resembles that of the British Museum Collections, the new atomic weights are employed, and the water specific gravities reduced to the hydrogen scale. So far as we can judge from a cursory inspection, this book will be found a compact and convenient guide to its subject.

Amongst miscellaneous books on our table, we may mention with commendation, the "Photographs of Eminent Medical Men," which Mr. Churchill is bringing out in a series of parts, and which continues to deserve the commendations bestowed upon earlier portions.

NOTES AND MEMORANDA.

A New Experiment in Physics.—M. Kommerell describes in Poggend. Annalen, the following experiment. A pulley wheel is made of a very short cylinder, having at each end glass disks of equal size, but much larger than the cylinder. A ribbon is wound round the disk several times, detaching itself tangentially on the under side. If this pulley-wheel is drawn up an inclined plane, not too steep, by means of the ribbon; it will be found that the wheel revolves and rolls itself up the ribbon. The friction of the wheel against the inclined plane is the cause of this curious action.

GROUP OF GOUTY-STEM TREES,

Adansonia Gregorii, near the Baines River, Victoria River, North Australia.

From an original oil-painting by T. Baines, in the Museum, Kew.

THE STUDENT,

AND

INTELLECTUAL OBSERVER.

JULY, 1868.

THE GOUTY STEM TREE.

(ADANSONIA GREGORII, MUELL.)

BY JOHN R. JACKSON, A.L.S.,

Curator of the Museum, Royal Gardens, Kew.

(*With a Coloured Plate.*)

In our last paper on the African species of Adansonia, we stated that the genus mustered only two species, one, as we there showed, a native of Africa, and the other a native of Australia, "A wide geographical difference in habit," our readers will no doubt say. It has been thought by some, that the two species might prove to be identical, and that the slight differences in their leaves, flowers, etc., might be the cause of accident, or some change in nature unknown to us, rather than a specific distinction; but in the general form of the Australian trees there is also some difference. It is known as well by distinct colonial names as by a distinct scientific one. Gouty Stem Tree, in allusion to its peculiar shape; or Cream of Tartar tree, or Sour Gourd, from the acid flavour of the pulp, are its colonial appellations. Cream of Tartar tree is derived from Krem tart boom, the name given by the Boers to the African tree.

The Gouty Stem tree is known to botanists as *Adansonia Gregorii*, which name was given to it by Dr. Ferdinand Mueller, of Melbourne, in honour of Mr. A. C. Gregory, the commander of the expedition sent by the Royal Geographical Society to explore North-West Australia during the years 1855, 1856, and 1857. *Adansonia Gregorii*

is confined to this part of Australia, growing chiefly on the sandy plains and low stony ridges, and extending from the Glenelg River to the western shores of Arnheim's land. Though it is not found exclusively in the vicinity of the sea coast, it seldom occurs more than a hundred miles inland. Many of the explorers into the region of these trees have recorded their surprise and amazement upon first beholding them, yet comparatively little is generally known about them. Captain King, who surveyed the Australian coasts, says in his "Voyage on the Coasts of Australia," "Mr. Cunningham was fortunate in finding the fruit of a tree that was first seen by us at Cambridge Gulf, and had for some time puzzled us from its immense size and peculiar appearance. It proved to be a tree of the natural order Capparidaceæ, and was thought to be a Capparri. The gouty habit of the stem, which was soft and spongy, gave it an appearance of disease; but as all the specimens, from the youngest plant to the full-grown tree, possessed the same deformed character, it was evidently the peculiarity of its habit. The stem of the largest of these trees measured twenty-nine feet in girth, while its height did not exceed twenty-five feet."

If the trees seen by Captain King did not exceed twenty-nine feet in circumference, they were small in comparison with those seen by Gregory's expedition, as we shall presently see. It is not to be wondered that they should hastily have been conjectured to belong to the natural order Capparidaceæ, especially if the trees were leafless at the time, and the members of the expedition had no previous acquaintance with the African species; from the external appearance of the fruit alone one might readily believe it to be a Capparri, and Allan Cunningham first described it as *Capparri gibbosa*. The botanical differences between this tree and its African brother, as we have before hinted, are not very marked. The leaves in this, as in the African species, are digitate, the leaflets entire, acuminate, and when fully grown, from four to five inches long, very slightly pubescent above, and covered with white tomentum beneath. The petals of the flowers, like those of *A. digitata*, are yellowish, or cream white, measuring quite four inches long. The calyx is oblong, entire in the bud, but splits into three or five lobes as the flower opens. The stamens are united into a column, but this column is not so long, neither are the filaments and anthers so densely crowded together in such a spherical mass as they are in the African species. The fruits in the Museum at Kew are not more than six inches long, and three or four inches wide; when ripe they assume a brownish yellow colour, and are covered

with a soft pubescence, from the woody rind or shell a dark red gum exudes.

From the foregoing description it will be seen that in the foliage and flowers of the two species there is a great similitude; the chief points of distinction seem to be that the leaflets are not so broad in the Australian tree as they are in the African; the calyx, also, is not so broad nor so regularly divided, the petals are narrower, and the filaments and anthers not so numerous or arranged together in such a globular tuft; it will also be observed that the fruits in the collection at Kew are smaller, though it is possible they may not be quite fully grown. The woodcut shows a leaf, an expanded flower, a flower-bud, and young fruit.

Dr. Bennett, in his "Gatherings of a Naturalist in Australia," says: "Whether in the valleys, on the borders of rivers, or in the forests, the tree attracts the attention of the traveller by the extraordinary forms it assumes, so unlike in character to other trees constituting the sylvan scenery around, even amid the surprising variety seen in tropical forests. The trunks, resembling gigantic yams, are filled with abundance of mucilage, very similar to gum tragacanth, forming a reservoir of aliment calculated for the climate in which these trees grow. In the valley of St. Trinidad several of them were scattered about, and among them was one particularly

conspicuous, not only from its large size and picturesque irregularity of form, but from its resemblance to the union of three trees in one. Unlike the others we had seen, it was almost entirely destitute of foliage; but this loss was amply compensated by its allowing the peculiar formation of the branches to be seen. This vegetable monster was laden with ripe fruit, pendent from long twisted spongy stalks, that varied in length from one to two feet, and the trunk was forty feet in circumference and sixty feet high; the bark is smooth, of a grayish colour. The termination of its larger stems had a remarkable form, being abruptly rounded; but from these rounded extremities branches were given off, which were out of all relative proportion to the height of the tree."

Both the Adansonias, when denuded of their leaves, and exhibiting more clearly their gaunt bare limbs, form a striking contrast to the evergreen forest vegetation so characteristic of tropical countries; but when in full leaf and flower, the cool green of the former and the delicate creamy white of the latter imparts a most refreshing and luxuriant character to the scene. In September, 1855, the expedition under Mr. Gregory's command entered the Victoria River, in North-West Australia, and while searching for water in the parched ravines, and incited onwards by the distant view of verdant herbage, they saw scattered through the valleys these very singularly formed trees; their great size and the gnarled appearance of their crooked branches made them objects of peculiar interest. At that time the trees were leafless, but the fruits were still pendent from the branches, while many were lying scattered beneath their spreading shade. Upon opening the fruits and tasting the pulp, which had become hard and dry, it was found to have retained its acid flavour; but the travellers were parched and in search of water, and failing in this they discovered that the trunks of the trees were exceedingly fleshy or succulent, and for the sake of the moisture which they contained they cut through the bark and outer portion of new wood, and taking out large pieces, which were more like wet sponge than wood, chewed them to allay their thirst. Though the wood of both species is soft and porous, and both equally useless either for timber or fuel, of the two the African seems to be the hardest, and to contain less sap or fluid matter. The wood of the Australian tree, when cut into chips, was readily devoured by the sheep belonging to the North Australian expedition. In a note from Mr. Baines, he says:—"Mr. Gregory and I went in search of water, and found about a gallon in a cleft, where we could only reach it by fixing the shell of a Gouty Stem

fruit in a cleft stick and lowering it down. Several pandani and Gouty Stems grew below, and one of the latter, about seven feet in diameter, having its outer layers of wood partially destroyed by fire, had fallen over, its soft stem wrinkling upon one side and distending on the other, like a roll of brown paper, without breaking in any part, till its top rested on the ground.

In the Museum at Kew is an oil painting representing a Gouty Stem tree at a station formed by the expedition on the Victoria River. The base of this tree was over thirty feet in circumference, and on the bark was painted, or rather daubed with yellow clay, a series of those grotesque figures of so much interest to the students of picture and gesture language. The figures represented were an emeu and a tortoise, while on other parts of the bark were carved or scratched some of the most grotesque forms. On another tree representations appear of a man, a lizard, and an animal something like a snake, but having horns, and ears, and two legs. At the back of the trees is a low rock, on which also figures have been painted or smeared in red, white, and black. It is not in our province to say, even if we could, what was intended to be conveyed by these singular readings. The figures are well represented in the paintings at Kew. Our readers will doubtless recollect that a notice of an interesting work on gesture language appeared in the INTELLECTUAL OBSERVER for July, 1865, vol. vii., p. 451.

Many of the trees, which appear at first to be gigantic single trunks, dividing above into three or more stout arms, upon a closer examination look suspiciously like a group of individual trees which when young have grown separately, but near each other, and as their circumferences have enlarged have become united, the dividing or radiating above being caused by the force of the continued enlargement. One tree particularly, noticed by Dr. Mueller and Mr. Baines, in latitude 160° 7′ south, longitude 130° 56′ east, consisted of five or six stems which seemed to have united as they enlarged, and at that time formed a solid mass to more than six feet from the ground. Their collective girth was fifty-eight feet.

The group of trees shown in the coloured plate grew near the Baines River, a tributary of the Victoria. The tree on the right hand of the plate had fallen from its upright position in a similar manner to the African trees; the trunks of some actually lie on the ground for a length of ten feet, and then rise into a perfectly upright position, bearing their dense masses of foliage, and flowering and fruiting apparently with as much vigour as their more normally-conditioned neighbours. Like the African tree, the creamy white

flowers first appear, then the young fresh green leaves, and as the flowers pass away and the young fruit forms, the leaves are also passing, till the fruit, matured and drying up preparatory to its fall, hangs amid the scanty remaining foliage. The fruits ripen about April, but they frequently hang upon the trees for some considerable time afterwards; the pulp, which consists of gum, starch, sugary matter, and malic acid, has the same pleasant acid flavour as that of the African Baobab. It is said to be very useful for the cure of scurvy, for which purpose the sailors of the North Australian expedition, when suffering from that disease, used to collect the fruits, and boil the pulp with sugar.

The Adansonias acquire a melancholy interest from the fact of their being chosen as a shelter for the last resting-place of explorers who have been unable to survive the hardships of their journeys, for while Mrs. Livingstone, who may justly lay claim to the title of explorer, is buried under an African Baobab, the carpenter of Mr. Gregory's expedition, who died in 1856, is buried under a Gouty Stem tree, into the bark of which a cross was cut by some members of the expedition.

THE DESATIR, AN ANCIENT RELIGIOUS BOOK OF THE FIRE-WORSHIPPERS.

BY E. H. PALMER, B.A.,

Fellow of St. John's College, Cambridge.

THE sacred books of any nation must possess an absorbing interest for all who desire to solve the great problem of human intellectual development. Considered as the direct utterance of inspiration, they influence every action of a people's life, and underlie its entire social and ethical system. But an authority like this must rest on something higher than the pretensions of an individual. Had Mohammed and Zoroaster been the designing impostors that too many suppose them to have been, the religion of the Koran and Zend-Avesta could never have been accepted as the faith of so many millions of the human race. It was not because these men founded new religions that their names have become watchwords in the East, but because they systematized the existing theosophic ideas, and adapted them to the exigencies of the age in which they lived, and of the people amongst whom they dwelt. It is in such books,

then, that we must look for the story of a nation's inner life—for the history of those principles upon which its laws and institutions are based. But if these remarks are true of the Scriptures of nations generally, how much more interest must attach to those of the earliest members of the Aryan race, the progenitors of that great family to which nearly all that is true or noble in the world is due.

The religion of Zoroaster was not a mere superstitious worship of fire, but the philosophical development of certain ethnical ideas, and its details are the natural outcome of that tendency to the observation of physical phenomena which has ever characterised the Aryan race. The Irani shepherd of old, as he gazed upon the hosts of heaven, and construed its myriad lights into so many glimpses of the effulgence of the Deity himself, was but pursuing the same course of investigation which led to the discoveries of Galileo and Newton. And when he advanced a step further, and, deducing from analogy that fire was the source of light, identified this element more or less with the nature of the Deity, he was but following his ethnical and instinctive inclination to natural philosophy. Nay, the same consideration that led him to this conclusion led also the Western philosophers to number fire amongst the primal elements of the material universe.

The earliest and most primitive form of Iranian religion of which any records have come down to us, is the Mahabadian, whose tenets are preserved in the Desatir.

This book is written in a dialect which, though akin to the modern Persian, differs, like that of the Zend-Avesta, from any other known form of Irani speech. It lays claim to the remotest antiquity, and is accompanied by a Persian translation and commentary, purporting to be the production of the fifth Sasan, who lived in the time of Khosrau Parvez, a contemporary of the Roman Emperor Heraclius, and who died in the year 643 of our era. I propose to discuss separately the name, date, and language of this work, to offer a brief analysis of its contents, and, lastly, to consider its value as a historical monument of Aryan theosophic thought.

The correct title of the book is "Vasatir." The copyist seems to have mistaken the *w*, و, for *d*, د, and the error to have been perpetuated, in consequence of the conformity of the word *desatir*, thus formed, with the Arabic plural of *dastúr*, which in Persian signifies a canon or rule. "*Vasatir*" is connected with the Sanscrit root भाष *bhásha* to speak, and means "an oracle."

The *Asmani* or "Celestial" language, in which the Desatir is written, has given rise to many controversies, and some of the most eminent Orientalists have not hesitated to deny altogether the antiquity of the work, and to pronounce the language an impudent forgery of modern times. Later criticism, however, assisted by the recent discoveries in comparative philology, has established the genuine character of the Asmani language, and assigned it a place amongst the most ancient forms of Persic speech. Anthony Troyer, in his preface to the Dabistan, has treated this subject in so masterly a manner, that I need do little more than recapitulate briefly his arguments in favour of the authenticity of the work. These are:—

The improbability of the forgery of a language which comparative philology could not detect.

That if the Desatir had been forged as a rival to the Koran, as many surmise, it must have been written in a national language for a nation.

That the identity of phraseology and construction which exists between the Mahabadi text and the translation which accompanies it, is rather an argument in support of the authenticity of the dialect, as a form of Persian speech, than of its factitious character. Moreover, this identity is constantly aimed at in the translation of important works.

That the existence of roots which seem to belong to the more modern dialects, such as the Hindí, is to be referred to the fact that popular and vulgar dialects often contain remains of ancient tongues: namely, words and locutions which have become obsolete, or disappeared in the cultivated idioms.*

That the structure and syllabic formation of the language, when compared with the modern Deri, display the same relation to it as the Gothic has to the English.

That, moreover, numerous Germanic radicals are found in the Mahabadian language which cannot be attributed to the well-known affinity between the German and modern Persian, because they are no longer to be found in the latter, but solely in the Desatir; but the accidental coincidence of an invented factitious language with Greek, Latin, and Germanic forms would be a greater miracle than the wonderful regularity of this ancient sacred idiom, and its conformity with the modern Deri.

* Thus, the Greek of the New Testament often brings back words and forms of speech which had been disused in the classical language since the time of Herodotus.

If some Arabic words are found in the Desatir, these afford no inference that these works had not been composed before the Arabs conquered Persia, because these words might have come from Pehlevi, in which there is an admixture of Arabic, as relations have subsisted between Persia and Arabia from time immemorial.

These considerations, and other internal evidence, have induced Mr. Troyer to regard the Asmani language "as a new intermediate ring in the hermetic chain which connects the Germanic idioms with the old Asiatic languages; it is, perhaps, the most ancient dialect of the Deri, spoken, if not in Fars, yet in the north-eastern countries of the Persian empire; to wit, in Sogd and Bamian. When it ceased to be spoken, like several other languages of bygone ages, the Mahabadian was preserved perhaps in a single book, or fragment of a book, similar in its solitude to the Hebrew Bible, or the Persian Zend-Avesta."

The Bibliographical history of the book is simply as follows: Although evidently well known to the older Persian writers (by whom it was regarded as the sacred volume of a particular sect), quoted in various works, and cited as an authority for obsolete forms by the author of the most celebrated of Persian dictionaries, it was entirely lost to the literary world until the year 1778, when a Parsee gentleman named Káûs purchased a copy accidentally, under the title of a Guebre book ("Kitábi Gabrí"), at a bookstall in Isfahan. His son, Mollah Firúz, one of the most learned Persian scholars that India has produced, published it at Bombay about forty-five years afterwards.

The Desatir consists of sixteen Books or Prophecies, attributed to the earliest sages and prophets of Iran. The first of them is that of Shet Mahabad, that is, the prophet the great Abad. This name, evidently Sanscrit in its origin, is applied to a dynasty said to have been established in Iran ages before the accession of Kaiomers, the first of Persian historical kings. Mahabad, we are informed by Mohsan Fani, the author of the Dabistan, ruled over the whole earth, and divided the people into four orders—the religious, the military, the commercial, and the servile, to which he assigned names unquestionably the same in their origin with those now applied to the four primary classes of the Hindus. It is said also that he received from the Creator, and promulgated amongst men, a sacred book called the Desatir; and that *fourteen Mahabads* had appeared, or would appear, in human shapes for the government of the world. "When we know," says Sir William Jones, in

commenting on this passage, "that the Hindus believe in fourteen Menus, or celebrated personages with similar functions, the first of whom left a book of regulations or divine ordinances, which they hold equal to the Vedas, and the language of which they believe to be that of the gods, we can hardly doubt that the first corruption of the purest and oldest religion was the system of Indian theology invented by the Brahmin, and prevalent in these territories, where the book of Mahabad or Menu is at this moment the standard of all religious and moral duties."

The book of Mahabad commences with a confession of the existence and unity of God (Mezdám), who is also called Lareng, that is, the Being without qualities:—

> "Existence, and Unity, and Identity are inseparable properties of His original substance, and are not adventitious to Him.
>
> "He is without beginning or end. . . .
>
> "He is Living, and Wise, and Powerful, and Independent, and Just, and His Knowledge extends over all that is heard, or seen, or that exists.
>
> "And all existence is visible to His Knowledge at once without time: and from Him nothing is hid."

It is interesting to observe how this idea of the Infinite, which seems to have gone through the whole system of Aryan philosophies, is expressed by one of the greatest thinkers and poets of modern times:—

> "Let there be light, and there was light: 'tis so;
> For was, and is, and will be, are but is;
> For all creation is one act at once,
> The birth of light."*

Then follows an account of the creation of the First Intelligence, or Khirid, through which proceeded the intelligences, and souls, and bodies which make up the system of the heavens; to each division of the heaven, that is, to each sphere, planet, etc., a separate intelligence and soul is assigned. This accords with the cosmogony of the modern Persian philosophy, in which the "Primal Intelligence" is said to have been the channel for communicating God's command for the creation of the universe, and in which also the planets are said to influence mankind through the intelligences which preside over them.

Heaven itself is thus described:—

> "Heaven is the abode of the Angels, the city of Souls, and the place of Spheres.
>
> "Whoever approaches the Angels sees the substance of the Lord of the World.

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* Tennyson's "Princess."

"The rapture thence arising no transport of the lower world can equal, the tongue cannot express nor the ear hear, nor the eye see such ecstacy.

"In the heavens there is joy such as none but those who enjoy it can conceive.

"The lowest degree of enjoyment in Heaven is such as is felt by the poorest of men when he receives a gift equal to the whole lower world.

"To the Celestials the bounty of the Most High Mezdâm hath vouchsafed a body which admits not of separation, which doth not wax old, and is susceptible of neither pain nor defilement."

The moon is placed lowest in the scale of heavenly beings, and below this is the position of the elements, from the combinations of which all terrestrial creatures are produced. Everything in nature has its guardian angel, down to the minutest particle of dust or the lightest cloud of mist. This tendency to people the whole vast extent of the universe with intelligent beings is an essentially Aryan idea. The Hindus and Greeks had their Uranian and Chthonian deities, their nymphs, demons, and presiding genii, and the Teutonic races their elves and gnomes; but in all these systems the notion of a power of evil antagonistic to the Creator's will is prevalent. In the Persian system, on the contrary, the universe is considered only as the abode of angels, and every intelligent being, whether real or hypothetical, is the glad and humble servant of God:—

"Among the most resplendent, powerful, and glorious of His servants who are free from inferior bodies and matter, there is none God's enemy or rival, or disobedient, or cast down, or annihilated."

The first ideas of the primitive Irani theosophists having been taken from an observation of the heavenly hosts, it was but natural that their religion, as it became more and more elaborated, should assume the form of a sidereal system. We therefore find that every notion of origin, antiquity, or eternity is referred to the celestial bodies, and time is divided into cycles of extravagant duration, regulated by the revolutions of the known planets and fixed stars. These cycles are fully described in the book of Mahabad and its commentary, and it is with a detailed account of his primitive code of society, couched in the form of commandments, that the rest of the first book of the Desatir is taken up. The spirit of this code may be expressed in a few words; it insists upon the worship and acknowledgment of one true God, on the observation of duty towards one's neighbour, and of a considerate regard for even the brute creation, as sharing equally with mankind in the blessings of the watchful care of Providence.

The second part of the Desatir is the book of the prophet Jai-

âfrâm, who succeeded Abadazar, the last of the Mahabadis. Of him the commentator says—

"Abadarad (Abadazar), the last Prince of the Abadians, having found mankind bent on evil, resigned the government, and went into retirement; and so effectually did he escape the observation of men, that no one knows where he went. In consequence of his abdication, the world fell into confusion, and the works of the preceding kings were destroyed. Then the good men went to Jaiâfrâm, the son of Abadarad, who was a recluse like his father, and who, from his fondness for retirement, always lived remote from mankind, and incessantly occupied with the worship of the Deity, and required him to assume the sovereignty, which, however, he declined, until the illustrious book came down to him."

The book of Jaiâfrâm does little more than insist on a proper comprehension of the Divine mysteries contained in the preceding one. It is chiefly remarkable for a beautiful liturgic list of the attributes of God, of which I cannot refrain from quoting a part:—

"The necessarily existent! Light of Lights! Lord of Lords! The Exalted! Of wonderful praise! Of supreme splendour! Of splendid brightness! The blessed giver! Of high purity! The Lord of brightness! The universal Creator! First of the first! Providence of Providences! God of intelligences! Lord of souls! The independent of the independent."

The book of Shet Shikaliv, which follows next, seems to aim at establishing the doctrine of the *exalted* nature of God, and of protesting against the idea of dualism and the anthropomorphic corruption that was already stealing into the Mahabadian creed:—

"That man is a perverter of truth who imagineth that likeness, or quantity, or locality, or body, or any accident among accidents, or any property among properties, can be predicated of Thee;

"Save from necessity, or as a form of speech, or for the purpose of intimation."

In the book of Shet Yasan, the next in the list, we see the tendency towards fire worship gradually developing itself, together with certain directions for ablutions and other ceremonial observances, which indicate the presence of an Indian or Vedantic influence. The worshipper is, however, warned not to confound the reverence due to the elements by which the Deity is symbolized with the Deity himself:—

"Reverence the four Elements, yet do not therefore lay thyself under restraint."

The two next books, those of Gilshah and Siamek, display rather more of the spirit of asceticism and contemplative speculation than is observable in the preceding writings. The language,

too, in which it is expressed, is that of a sect of mystics or illuminati, protesting against the increasing corruption of the primitive faith. This protest finds more full utterance in the book of the prophet Hosheng, called Sed Wakhshur, or "the Hundred-Prophet." Hosheng is universally regarded as the founder of the religion which bears his name; but he was in reality merely the restorer of the simplicity of the primæval faith.

The tenets of the Hoshengis, as they are described in the Dabistan, differ little from the Mahabadian doctrines of the Desatir. These doctrines continued to be professed as an esoteric faith in Iran for many ages. The author of the Dabistan informs us that when Alexander arrived in Persia he found a sect existing there called Gushaspis who claimed Hosheng as their founder, and who, though openly professing the religion of Zoroaster, preserved the tenets taught by Hosheng as the esoteric doctrine of Pyrolatry. The book of Hosheng in the Desatir is full of denunciations, evidently levelled against those who had formed gross conceptions of the Deity, and contains frequent prayers for spiritual illumination:—

"I pray . . . . that He would make me one of those who approach near unto Him, and of the Band of His Lights, and of the company of those who are admitted into the secrets of His essence!"

The books of Tahmuras and Jemshid differ little from those of Hosheng, save that they insist more on the importance of the sun as the source of light, and, as such, entitled to adoration. That of Jemshid contains a curious disquisition upon the personal individuality of the world, and the harmony of all its parts:—

"I created the world an individual," says the text of the Desatir, and the commentator proceeds to explain this statement as follows:—"For the whole world is an individual. Its body, which is composed of all bodies, is called the Universe (Tehîm); its soul, which consists of all souls, is called the City of Souls (Rewângird); and its intelligence is composed of all the intelligences, and is called the City of Understanding (Hoshgird). This is the Great Man. When you have contemplated this World so wonderful, it is but one of His worshippers. If you open the eye of your heart you will perceive that the Heaven is the skin of this Great Individual; Kaiwán (Saturn), the spleen; Barjish (Jupiter), the liver; Behrám (Mars), the gall; the Sun, the heart; Nahid (Venus), the stomach; Tir (Mercury), the brain; and so on. The air is his

breath; the water his sweat; the earth the place on which he steps; the thunder his voice; the lightning his laugh; the rain his tears."

There is a traditional saying of Mohammed, in which this same notion lurks, and which affords a good instance of the way in which Persian ideas were preserved in the semi-Sabæan legends of the ante-Islamitic Arabs. It is related that the prophet, when he saw the lightning and heard the thunder, was wont to say, "Oh, God, destroy us not in thy wrath, but (if Thou wilt), pardon us ere thou doest so. The thunder is the voice of an angel heard in the clouds, and the lightning his laughter; and when his anger is severe, then fire issueth forth from his mouth, and that causeth the thunderbolts."

In both the books of Tahmuras and Jemshid the wickedness and increasing depravity of mankind is deplored, and punishment threatened. Similarly, the books of Faridun, Menuchehr, Kai Khosrau, and Zertusht (Zoroaster), contain no fresh ideas; but it is worthy of remark, that in the one ascribed to Zoroaster the revelation made to that prophet is said to be strictly identical with the faith delivered to Mahabad:—

"Unto whomsoever I grant the gift of prophecy while waking, to him do I deliver the religion of the Great Abad. This religion is My Beloved."

The commentary on this part of the Desatir contains the following interesting anecdote of Zoroaster:—"When the fame of the excellence of Zertusht had spread over all the world, and when Isfendiar went round the world, erected the temples, and raised domes over the fires, the wise men of Yunán (Greece) selected a sage named Tutianush, who in that time had the superiority in acquirements over them all, to go to Iran, and inquire of Zertusht concerning the real nature of things. If he was puzzled and unable to answer, he could be no real prophet; but if he returned an answer, he was a speaker of truth. When the Yunáni sage arrived at Balkh, Gushtasp appointed a proper day on which the Mobeds of every country should assemble, and a golden chair was placed for the Yunáni sage. Then the Beloved of Yezdán (God), the prophet Zertusht, advanced into the midst of the assembly. The Yunáni sage, on seeing that chief, said, 'This form and this gait cannot lie, and nought but truth can proceed from them.' He then asked the day of the prophet's nativity. The prophet of God told it. He said, 'On such a day, and under such a fortunate star, a deceiver cannot be born.' He next inquired into his diet

and mode of life. The prophet explained the whole. The sage said, 'This mode of life cannot suit an impostor.' The prophet of Yezdán then said to him, 'I have answered the questions which you have put to me. Now retain in your mind what the famed Yunáni sages directed you to inquire of Zertusht, and disclose it not, but listen, and hear what they ask; for God hath informed me of it, and hath sent his word unto me to unfold it.' The sage said, 'Speak.' Thereupon Zertusht the prophet ordered his scholar to repeat some texts of the Desatir, which form an answer to the inquiries which Tutianush had been sent to make."

The remaining books are, that entitled the Book of Instructions to Alexander, and those of Shet Sasan the First and Shet Sasan the Fifth. In the first-mentioned writing Alexander is made out to have been the son of Darab, and grandson of Behman, and is said to have been miraculously transported from Persia to Greece, to become the instrument of retaliation upon the Iranis for his father's murder. In this book the first Sasan is predicted as the one who shall make known the contents of the Desatir through a translation and commentary. The fifth Sasan, to whom we owe the present commentary that accompanies the Desatir, and whose book concludes the Desatir, was evidently a thorough enthusiast in the cause of the Mahabadi faith, and it is curious to notice that his enthusiasm led him into a delusion similar to that which seems to have influenced certain visionaries in modern times—I mean, the idea of physical elevation, and actual intercourse with the spiritual world:—

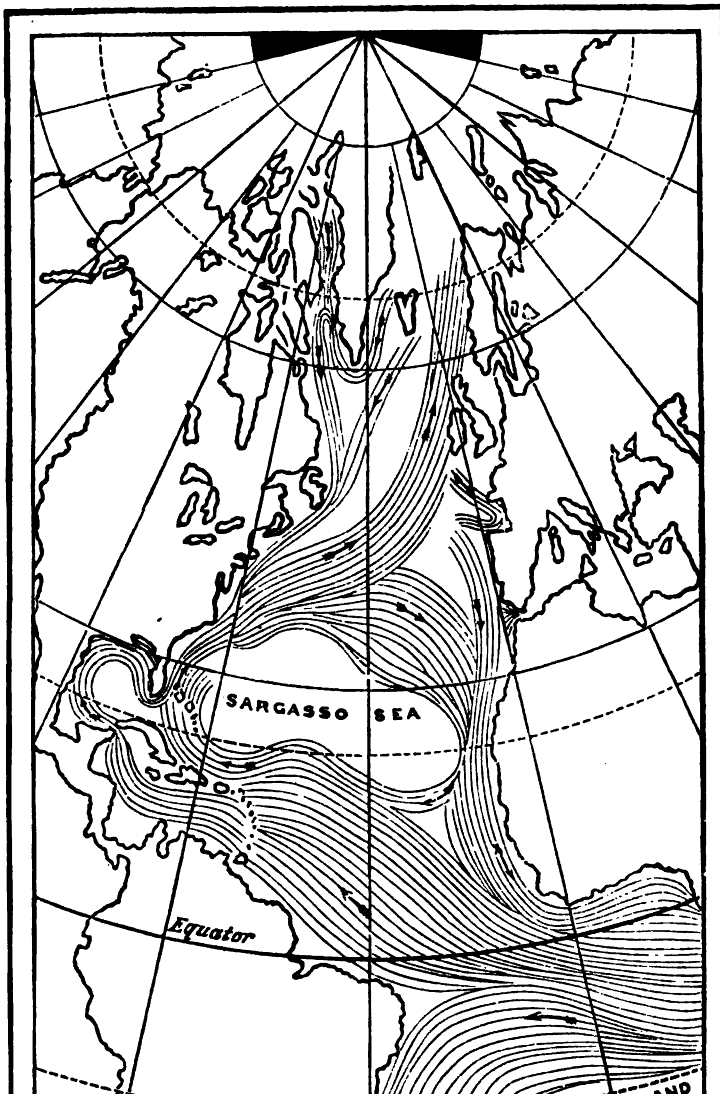
"At the time when Yezdán sent this his humble adorer to Merv, in the time of Parvez, my respected father received this revelation from the world above, and the grandees and the King of Kings also saw it in a dream, and, coming in a body, attached themselves to my sect. And the Most Just elevated me aloft so many times that I cannot reckon them, and these elevations are still continued. And I beheld the place of bodies like a drop in the ocean of souls; and I saw the place of souls like a drop in the place of intelligences, and the place of intelligences like a drop in the ocean of the Divine Essence."

It is impossible to decide who the author of the Mahabadi text really was, or to what age it belongs. The gradual development of religious ideas mentioned in the preceding analysis would seem to show that a considerable time elapsed between the composition of the several parts of the Desatir. The latter portions of the work are full of historical allusions and prophecies after the event, that

must be regarded as interpolations of more modern times, a corruption from which the Vedas themselves are not free. For example, the two last books of the Desatir contain prophecies of the dissensions in the Abbasside and Ali families, of the adoption of Islam by the greater part of the Eastern nations, and of the rise of the Tatar and Turcoman powers. But these considerations do not outweigh the great mass of internal evidence in favour of the antiquity and authenticity of the book, and especially of the part attributed to Mahabad himself, which probably formed the nucleus of the entire work. It affords a most interesting monument of the rise and progress of Persian religious ideas, and contains, on the lowest supposition, the traditional account of the most primitive religion of the East. It is the expression of the earliest yearnings of the Aryan mind after truth—the dreamy enthusiasm of one who believed that he had fathomed the secrets of Heaven itself, that—

"The great Intelligences fair,
That range above our mortal state,
In circle round the blessed gate,
Received and gave him welcome there;

"And led him thro' the blissful climes,
And showed him in the fountain fresh
All knowledge that the sons of flesh
Shall gather in the cycled times."



ISOGRAPHIC CHART OF THE ATLANTIC OCEAN, SHOWING THE COURSE OF THE GULF STREAM, ETC.

THE GULF STREAM.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

(*With a Map.*)

MAJOR RENNELL was the first, I believe, to whom we owe the comparison of ocean-currents to rivers. He spoke of them as ocean-rivers, and pointed out how enormously their dimensions exceed those of such streams even as the Amazon and the Mississippi. Some of the ocean-currents are from 50 to 250 miles in breadth, and flow more swiftly than the largest navigable rivers. The banks and bottom of these currents are not land, but water; and so deep are the currents that they are turned aside by shoals and banks whose tops are "40, 50, or even 100 fathoms beneath the surface of the ocean." The outlines of ocean-currents are sharply defined, insomuch that "often," says Captain Maury, "one half of a vessel may be seen floating in the current, while the other half is in common water of the sea." The border-line of the Gulf Stream can be traced by the eye. Yet more remarkable is the distinction between the moving water and that which is at rest, when large masses of sea-weed carried along by the former enable one to recognize the rapidity with which it moves.

Of all the ocean-currents the most important, perhaps, in its bearing on the destinies of men and nations, is the great Gulf Stream. I propose to examine the course and latitudes of this current, and then to inquire a little into the vexed question of its cause.

Major Rennell traced the Gulf Stream from a supposed source in the Indian and Southern Oceans. Modern geographers and physicists prefer to look for the rise of the current somewhere near the Cape of Good Hope. "The commencement and first impulse of the mighty Gulf Stream is to be sought," writes Humboldt, "southward of the Cape of Good Hope." It appears to me, however, that the true source of the great stream is to be looked for in the equatorial zone of the Atlantic. When we come to inquire into the cause or causes which give birth to the Gulf Stream, we are led, as I imagine, to this region rather than to any other (though, perhaps, in a stream which forms part of a continuous system of circulation, we can hardly speak of any one portion as the source); I shall therefore trace the stream, and the system to which it belongs, from the great equatorial waters which move, as Columbus was the first

to discover, "with the heavens (*las aguas van con los cielos*), that is, from east to west, following in this the apparent motions of the sun, moon, and stars."

The accompanying map of the Atlantic Ocean is constructed upon one of those forms of isographic projection considered in my paper on such projections ("Intellectual Observer" for July, 1866). It is important, in dealing with the subject of currents, that the question of area should be considered, and, therefore, that our illustrative charts should represent such areas correctly. This Mercator's charts are far from doing. The portion of the Atlantic Ocean between England and the United States of America is unduly magnified, and still more is this the case with the portion between Sweden and Greenland. On the other hand the portion between Africa and the Gulf of Mexico is unduly diminished. Thus it is scarcely possible to form just notions from such charts of the actual character of the oceanic circulation whereof the Gulf Stream forms a part.

We see, in our map, that there is a great equatorial stream extending in its eastern portion far to the south of the equator, but passing to the north also even here, and still further to the north between the coasts of Africa and South America. Near here the great equatorial current divides into two portions. One passes southward, and then returns towards the east according to some authorities, but, according to others, continues its course southward until it is lost in the Antarctic Ocean. We shall follow the northern bifurcation, however. The course of this portion of the Atlantic current-system has been far more exactly traced out. Taking a north-westerly course, the great current pours itself against the barrier formed by the Leeward and Windward Islands. Passing between these islands, it sweeps around the shores of the Gulf of Mexico, a portion, however, of its volume passing probably outside the West Indian Islands, to rejoin the other outside the promontory of Florida. At this point the stream has become, probably, somewhat diminished in volume, but being still more diminished in breadth, it flows as a deep, strong, and swift stream, known among sailors as "The Narrows of Bemini." From hence the stream, now become the true Gulf Stream, grows gradually wider, less deep, and less swift. Off Hatteras it is already twice as broad as in the Florida Straits, and as it stretches with a wide easterly sweep across the Atlantic towards the shores of Ireland and the Hebrides, the current not only reassumes something of its original extent of surface, but again bifurcates; a wide but somewhat sluggish stream

is sent southward towards the shores of north-western Africa, to rejoin the equatorial stream. The main portion of the current, however, passes with a north-easterly course up the Atlantic valley, between Iceland and Sweden to the Polar seas. It seems uncertain whether Rennell's current, which passes around the Bay of Biscay, and the current which streams southward past the shores of Spain, are forks of the Gulf Stream. They are usually represented in maps as independent currents, and in Captain Maury's large map of the Gulf Stream the great southern bifurcation, already mentioned, is represented as a current impinging upon the flank of the stream which flows past Spain and north-western Africa. Yet, if these streams have not their source in the Gulf Stream, it will be found no easy problem to assign their origin; and I cannot but think that the Biscay and Guinea currents, as well as the current which flows into the Mediterranean through the Straits of Gibraltar, are as truly bifurcations of the Gulf Stream as the current which laves the shores of Ireland and Sweden.

There will be noticed also in the map three return streams, one flowing southward outside Iceland, another sweeping round the eastern shores of Greenland, and the third flowing through Baffin's Bay and Davis's Straits. The two last unite south of Davis's Straits, and flow on together to meet the first stream outside Newfoundland, whence the three flow as a single current past the shores of the United States. It is generally assumed, and in all probability justly, that these three streams are derived from the Gulf Stream, and are different branches of its returning waters.

Between the single return-stream which laves the shores of the United States and the Gulf Stream there is an unshaded space in the map. It is not to be inferred, however, that this space represents still (or rather unflowing) water. On the contrary, it is the "debateable ground" between the opposite currents. In spring the whole of this space is occupied by the southward-flowing waters of the cold return current. In autumn the whole of the space is occupied with the waters of the Gulf Stream. Backwards and forwards over this space the rival currents are continually swaying, the period of an oscillation being one year.

In the widest part of the Atlantic Ocean, that, namely, which extends between the most westerly part of Africa and the West Indies, there is a wide expanse of waters unmoved by the flux or reflux of currents. Surrounded on every side by the circulating waters of the Central Atlantic current-system, this region remains undisturbed save by winds and the tidal wave. Accordingly its

surface is covered with different forms of marine vegetation. My readers will doubtless remember the interest which the Great Sargasso Sea excited in the mind of Christopher Columbus. Oviedo termed this region the "seaweed meadow." "A host of small marine animals," says Humboldt, "inhabit this ever-verdant mass of *Fucus natans*, one of the most widely diffused of the social plants of the ocean, constantly drifted hither and thither by the tepid winds that blow across its surface."

In the South Atlantic there is a smaller and somewhat more sharply defined Sargasso, covered chiefly with rockweed and drift. A weedy space occurs also about the Falkland Islands, but is probably not a true Sargasso. Maury considers that the seaweed reported there probably comes from the Straits of Magellan, where it grows so thickly that steamers find great difficulty in making their way through it. It so encumbers their paddles as to make frequent stoppages necessary.

Such is the distribution of the surface of the Atlantic Ocean. But now the question will at once suggest itself: Is the complete system of oceanic circulation exhibited on the surface? It seems now quite certain that this question must be answered in the negative. We might, indeed, at once point to the existence of the important current which laves the shores of the United States as an answer to the question; for where can all this water find an outlet? It does not pass the Peninsula of Florida as a current; it does not cross the Gulf Stream; where then can it go but underneath the ocean's surface? But we have positive evidence of the existence of under-currents.

In the first place it is found that in deep-sea soundings in many parts of the ocean, far more line may be paid out without any sign of the bottom being reached than the depth of the ocean in those parts would account for. In places where it has been proved by other methods than ordinary sounding that the depth is not more than three miles, no less than ten miles of line have been paid out, being carried out so strongly that the slightest check in the paying-out apparatus has sufficed to break the sounding-line.

In the second place, it has been found possible to determine the depth at which a submarine current is flowing, and the direction in which it flows. Thus Lieuts. Walsh and Lee, in the American service, having loaded a block of wood to sinking, and let it down to different depths, had repeatedly the satisfaction of seeing the work of under-currents. "It was wonderful, indeed," they write, "to see the *barrega*" (a float attached to the upper end of the

line) "moving off, against wind, sea, and surface current at the rate of over one knot an hour, as was generally the case, and on one occasion, as much as one and three quarter knots. The men in the boat could not repress exclamations of surprise, for it really appeared as if some monster of the deep had hold of the weight below, and was walking off with it."

Lastly, we may mention that Captain Wilkes, of the United States Exploring Expedition (and later of Trent notoriety), established the existence of a cold under-current no less than two hundred miles broad at the equator.

We may assume, then, that a complete system of circulation, vertical as well as horizontal, exists throughout the whole of the waters contained within the great Atlantic valley.

Where are we to look for the origin of this vast series of movements? The actual "work done" in the Atlantic Ocean is so enormous—in other words, the transfer of such large volumes of water represents so enormous a *force*, that we might well expect to be able at once to assign the motive-power of this great machinery. For it would seem that the giant which works such wonders could not readily hide himself from our recognition.

It has not been found, however, that the solution of the problem has been so simple as was to have been anticipated.

Passing over the earlier guesses which marked the Gulf Stream as the offspring of the Mississippi River, of the sun's motion in the ecliptic (a mysterious interpretation of the phenomena), and of the tidal wave, we may remark that but two explanations of the Atlantic currents seem to merit discussion.

Sir John Herschel is the principal exponent of the first theory, which assigns to the trade-winds the principal—almost the sole—agency in the generation of the Atlantic current-system. He refuses indeed, to look on the subject as one of any doubt or difficulty. "The dynamics of the Gulf Stream have of late," he writes, "been made a subject of much (we cannot but think misplaced) wonder, as if there could be any possible ground for doubting that it owes its origin *entirely* to the trade-winds." "If there were no atmosphere, there would be no Gulf Stream, or any other considerable oceanic current (as distinguished from a mere surface-drift) whatever." He presents his solution somewhat as follows:—The trade-winds are an actually existent cause for an easterly motion in the tropical seas; we cannot ignore their action; we know, also, that when the trade-winds arrive at the equator, they have lost their easterly momentum; and we know, therefore, that that momentum

must have been imparted to the surface of the water (for where else can it have gone?); hence there arises the great easterly movement which generates the whole system of circulation.

The second view, which attributes oceanic circulation to differences of temperature and saltness in different parts of the ocean, is supported by Humboldt and others, but is taken up most unflinchingly by Captain Maury, who assigns it as practically the sole cause of all oceanic circulation. "The Gulf Stream," he writes, "as well as all the *constant* currents of the sea, is due mainly to this cause. Such differences are inconsistent with aqueous equilibrium, and to maintain this equilibrium the great currents are set in motion. The agents which derange equilibrium in the waters of the sea, by altering specific gravity, reach from the equator to the poles, and in their operations they are as ceaseless as heat and cold; consequently, they call for a system of perpetual currents to undo their perpetual work." "Other causes *help* to cause currents," he says, "but the currents created by them are *ephemeral*."

Here we have what is "a very pretty quarrel as it stands." Each of the disputants points to causes of acknowledged importance, and also (whether efficient or not in the particular respect under question) of acknowledged general efficiency. Each has much to say in favour of his own view, and each considers his antagonist's agent as utterly insufficient for the work ascribed to it. Each has heard his opponent's arguments, and reiterates his own statement. Nor can it be said that the opponents are unequally matched; for, if we must place Sir John Herschel far before Maury as a mathematician and physicist, and if we must undoubtedly look upon the former as the more practised reasoner, yet we must remember, in turn, the special attention which Captain Maury has given to the subject under discussion, and the practical acquaintance with it which his experience as a seaman has given to him.

Let us briefly state the arguments adduced by Herschel against Maury's view, and by Maury against Herschel's.

Sir John Herschel asserts that, inasmuch as the sun's heat warms the *surface* of the ocean most intensely, so that the water of least specific gravity is already uppermost, there can be no tendency to motion. For the heated water cannot *descend*, being buoyant; nor *ascend*, being uppermost; nor move *laterally*, having no impulse to motion of that sort, and being only able to move laterally "by reason of a general declivity of surface, the dilated portion occupying a higher level." He then applies to this declivity the test of quantitative analysis. Taking a column of water at the equator

having at the base a temperature of 39° (at which temperature fresh water attains its greatest density, and which is also the temperature of water 7200 feet beneath the surface at the equator), while its top has a temperature of 84° (the warmth of equatorial surface-water), he finds that such a column is 10 feet higher than a similar column in latitude 56°, where 39° is the surface temperature. And since from the equator to latitude 56° the distance is 3360 geographical miles, we have a declivity of barely one-twenty-eighth of an inch per geographical, or one-thirty-second of an inch per statute mile. Such a declivity is utterly insufficient to account for the existence of a strong current from the equator towards the tropics; while, so far from giving any account of the motion of the equatorial current from east to west, it would tend to form a north-easterly current.

This seems strongly opposed to Maury's view, and I do not find that he does much to get over the force of Herschel's reasoning. He points out, indeed, that sea-water does not attain its greatest density at a temperature of 39°, but some 12° or 14° lower. This, however, does not affect Herschel's argument. If he had taken a column whose base had a temperature of 25° instead of 39°, he would have had to extend, also, the range of the water-slope in latitude; and, in fact, he would have obtained a yet smaller declivity in this way than that actually deduced by him. Maury does not seem to have noticed the really weak point in Sir John's argument. I shall presently show where this seems to me to lie.

But if Maury fails in efficiently defending his own views, he certainly is sufficiently effective in his attack upon Sir John Herschel's.

He asks, in the first place, the pertinent question—How can the north-easterly trade-winds, which blow only 240 days out of 365, cause the equatorial current to flow all through the year towards the north-west, without varying its velocity either to the force or to the prevalence of the trade-winds? "That the winds do make currents in the sea, no one," he says, "will have the hardihood to deny; but currents that are born of the winds are as unstable as the winds; uncertain as to time, place, and direction, they are sporadic and ephemeral."

He then points to a fact which "militates strongly against the vast current-begetting power that has been given by theory to the gentle trade-winds. In both oceans, the Sargasso seas lie partly within the trade-wind region; but in neither do these winds give rise to any current. The weeds are partly out of water, and the wind has therefore more power upon them than it has upon the

water itself; they tail to the wind. And if the supreme power over the currents of the sea reside in the winds, as Herschel would have it, then of all places in the trade-wind region, we should here have the strongest currents. Had there been currents here, these weeds would have been borne away long ago; but so far from it, we know that they have been in the Sargasso Sea of the Atlantic since the voyage of Columbus."

In another argument, Maury certainly falls into an error. He says, How can the north-easterly winds cause the Gulf Stream to flow *towards* the north-east? But, as he himself points out, the trade-winds do not blow over the Gulf Stream proper, and there can be no doubt that, if the trade-winds sufficed to keep up a continual equatorial current, finding a passage towards the north after encountering the barrier opposed by the American continent, this resulting northerly current would assume a north-easterly course, for the very same reason that the air-currents, flowing from the equator towards the north pole, become south-westerly or counter trade-winds. But he seems justified in asking how it is possible that the impulse imparted by the gentle trade-winds to the equatorial current could suffice to generate a stream which eventually travels far towards the north pole, if it do not even circle completely around Greenland. "When we inject water into a pool," he says, "be the force never so great, the jet is soon overcome, broken up, and made to disappear. In this illustration, the Gulf Stream may be likened to the jet, and the Atlantic to the pool. We remember to have observed, as children, how soon the mill-tail loses its current in the pool below; or we may now see at any time, and on a larger scale, how soon the Niagara, current and all, is swallowed up in the lake below."

Franklin, who was the originator of the theory supported by Herschel, had unnecessarily introduced the supposition that the trade-winds maintain a "head of water" in the Gulf of Mexico, and that the Gulf Stream flows downwards like a river from this "head," as a fountain or source. Maury rightly attacks this view, which is undoubtedly a mistaken one; but in doing so, he falls into an error which exhibits his weakness in the treatment of hydrodynamical problems. He points out that, inasmuch as the Gulf Stream grows wider as it crosses the Atlantic, it necessarily grows shallower, so that the water-bed in which the stream flows has a higher level under the shallow than under the deep part of the current, and therefore, says Maury, "*the current runs up hill.*" Herschel terms this a strange perversion of language, but perhaps

it would be more correct to speak of it as a strange blunder. The stream could, of course, only be said to run up hill if *its surface* were seeking a higher level, which does not and cannot happen. That the spreading out of the water of the current, so as to form a wider and shallower stream, does not correspond to an upward flow, is evident from this, that it happens often with rivers, which no one will suspect of *running up hill.*

Herschel does not find an answer to the main objections urged by Maury against the trade-wind theory. Content with urging an apparently unanswerable objection against his opponent's view, he leaves his own to take care of itself.

In forming an opinion respecting the two theories, one is struck with the immense superiority in the *power* of Maury's agent. For, if we consider, we shall see that almost *the whole of the sun's action upon the ocean* goes to produce those variations in temperature and saltness in which Maury sees the origin of the current-system; but a very moderate portion of the sun's action is called into play in the production of the trade-winds. Now it is very doubtful whether any large proportion even of the force expended in producing the trade-winds, ever acts on the water. For we know that the north-easterly and south-easterly air-currents of the northern and southern hemispheres, do not wholly merge into northern and southern currents meeting point-blank near the equator, as Herschel's theory seems to imply. On the contrary, there is a wide zone of calms at the equator, and the two systems of trade-winds appear to pass upwards above the calm air, without parting with the whole of their easterly motion. When once they begin to travel polewards, they lose their easterly motion in the same way that they acquired it—that is, through the effects of the earth's rotation. And whatever portion is lost in this way—which, for aught we know, may be a very considerable portion, cannot be taken into account as available to generate the easterly equatorial current.

And now let us consider for a moment the relation which holds between cause and effect in the case supposed by Herschel. We have more than a fourth part of the Atlantic Ocean in a state of perpetual motion, and it is assumed that the air immediately above the ocean is responsible for this circulation. Now even if we suppose that the whole of the *vis viva* in the aërial circulation is imparted to the waters, and neglect all consideration of the fact that for a large portion of the year the winds do not act in the manner available for the production of the currents we are considering, yet even

then, I apprehend that we shall find the *vis viva* of the aërial very far below that of the aqueous circulation. The volume of moving water is, of course, far less than that of the moving air, and the mean velocity of the water-currents is less than that of the air-currents; but on the other hand, the specific gravity of water is some 830 or 840 times greater than that of air, and this difference far more than counterbalances the others.

But now when we come to consider the forces called into action in producing changes of temperature, etc., we no longer find such a disproportion between cause and effect. The sun's action on the equatorial and tropical regions of the Atlantic not only produces a great change in the density of the water, but also raises immense masses by evaporation. Now the buoyancy caused by increase of temperature is partly diminished through increase of saltness, still it is an important motive-force. A large portion of the evaporated water is also precipitated over the equatorial regions in the form of rain; yet that a very large portion is carried away from equatorial and tropical to temperate zones is beyond dispute.

But now, how are we to get over the arguments by which Herschel seeks to show that the buoyant water will not rapidly move off, and that the effect of evaporation is merely to produce opposing inrushes of water which destroy each other's effect? Easily, I take it, if we remember that the buoyancy of the water *does* produce a surface-flow from the equator, however slight, and that this is sufficient to destroy the balance of forces which might otherwise make it doubtful whether the place of the evaporated water would be supplied from below or from above. I apprehend that there is a continual under-flow of cooler water, rushing in towards the equator on both sides, to supply the place of the water evaporated by the sun's heat. Now there can be no question that under-currents arriving in this manner, whether from the north or from the south, would acquire a strong westerly motion (just as the trade-winds do). Thus they would generate *from below* the great equatorial westerly current. In this up-flow of cool currents having a strong westerly motion, I find the mainspring of the series of motions. The water thus pouring in towards the equator is withdrawn from beneath the temperate and arctic zones, so that room is continually being made for that north-easterly surface-stream which is the necessary consequence of the continual flow of the great western equatorial current against the barrier formed by the American continent.

It would require much more space than I have at my disposal to

deal at length with the subject of my paper. I therefore conclude by referring my readers to Maury's interesting work on the "Physical Geography of the Sea," with the remark that his views seem to me only to require the mainspring or starting force towards the west which I have ventured to suggest, to supply a complete, efficient, and natural explanation of the whole series of phenomena presented by the great ocean-currents.

ON THE ZOETROPE AND ITS ANTECEDENTS.

BY WILLIAM B. CARPENTER, M.D.,

Vice-President of the Royal Society.

It is not generally known even among scientific men, still less to the general public, that it was the fertile brain of Professor Faraday which furnished the original *idea*, whose subsequent development in other hands has given rise to a whole class of remarkable effects—commonly called *optical*, but partly (as will hereafter be shown *mental*)—which are interesting alike to the philosopher and the mere wonder-seeker, to the educated and to the uneducated, to the old and to the young. Of the instruments through which these effects are produced, the *Zoetrope* is the latest, and in many respects the best; especially because its effects may be witnessed by almost any number of persons at a time, without requiring any cumbrous apparatus for their display. But it is not *in principle* at all in advance of the *Phenakisticope* and *Stroboscope*, the invention of which followed almost immediately upon the publication of Professor Faraday's observations, and which were introduced into this country from the Continent more than a third of a century ago.

As the writer well remembers the interest excited in his own mind by the publication in 1831 of Professor Faraday's paper,* "On a peculiar class of Optical Illusions,"—having still by him the apparatus which he constructed at the time to repeat and extend Professor Faraday's experiments,—and as he has since followed with like interest the subsequent developments of that great philosopher's "idea," he has thought it a not inappropriate time to recall that idea to general attention; and to endeavour to explain to those who have recently had their wondering attention drawn to the curious phenomena exhibited by the Zoetrope, the principles on

* "Journal of the Royal Institution," vol. i., p. 205.

which its effects depend. He proposes in a future paper to bring before his readers some of the more remarkable of those less known developments, which the same principles have received under the scientific treatment of Professor Plateau of Liège; whose first inquiries on this subject, which were yet earlier than those of Professor Faraday, had led him to the invention of that very curious instrument the *Anorthoscope* (which is but little known in this country) as far back as 1836.

The first of these principles is that of the *persistence of a visual impression for a determinate interval*, after the object which made it has been withdrawn, or has changed its place.* Of this general fact we have an illustration in the luminous "tail" left by a rocket or of a shooting-star; and in the experiment, which every child knows how to make, of the production of a fiery circle by whirling round a lighted stick in the dark. For in each of these instances, the trail of light which seems to be left behind the luminous object in motion marks the continuance of the visual impression made by it, after its actual image has quitted one part of the retina for another; and the length of that trail increases in proportion to the rate of movement of the object. Hence the child's experiment, if performed with scientific precision, may be made to give a measure of the duration of the impression; for it will be at once seen, that if the luminous point be made to revolve with just sufficient rapidity to complete the luminous trail into a complete circle, the time occupied by a single revolution is that of the persistence of the impression left at any one spot, until it becomes continuous with the new impression made by the return of the object to the same spot. This interval is usually stated to be about one-seventh or one-eighth of a second; but the writer has reason to believe, from experiments

* It is commonly said that "the image remains on the retina;" but this is manifestly incorrect, since the image cannot remain after the withdrawal of the object which caused it. It would be less objectionable to say that "the impression produced by the image remains upon the retina after the image itself has departed:" and this, the writer believes, is the ordinary scientific representation on the subject. It is open to question, however, whether it is a true account of the fact. There is no doubt that a prolonged gaze at a luminous object *does* produce an impression upon the retina, which persists for some time afterwards, manifesting itself in the *spectrum* of the object which is seen when the eyes are closed, or are directed elsewhere. But the persistence of a mode of organic action which has been kept up in a certain part of the retina for an appreciable time, is very different from the persistence of an impression caused by an image of which the duration may not have been more than one millionth of a second; and the writer is disposed to regard this last as rather a *mental* than a *retinal* phenomenon. At any rate, it is better to use language which expresses the *fact* independently of *theory*.

which he formerly made, that it varies in different individuals, and in the same individual under different circumstances,—a more rapid revolution being required when the visual impression is faint, than when it is vivid; the latter, as might be anticipated, enduring longer than the former, so as to produce a continuous circle by a slower movement.

This principle has been applied in various scientific toys, of which one of the earliest was the *Thaumatrope* of Dr. Wollaston. This consists merely of a circular disk of card, on each face of which a figure is painted, having a string attached to each end of the diameter crossing the figure, by which the card may be spun round that diameter as an axis. For since the successive impressions left by each of the full faces of the card, as they pass before the eye, become continuous with each other if renewed with sufficient frequency, the figure borne on one face is seen superposed on that borne on the other; and thus, if a bird be painted on one face and a cage on the other, or a vase on one face and a bouquet on the other, the revolution of the disk will cause the bird to be seen in the cage, and the bouquet in the vase. The distinctness of the image is of course impaired by the fact, that as the card is seen during the whole of its revolution, the two figures are presented to the eye in every successive phase of fore-shortening, as well as in full view; but as the latter makes the stronger and more persistent impression, it is that which forms the combined picture. The experiment may be easily varied by printing a word in large capitals on the two sides of the card, in such a manner that the upper half of each letter is on one side of it, and the lower half of it on the other; and if the relative places and positions of these two halves have been rightly adjusted, the revolution of the card will make them combine into one complete whole.

The *Colour-Top* of Mr. Gorham, again, presents a number of beautiful illustrations of the same principle, a description of which will be found elsewhere;* but we must stop to notice the elegant application of that principle to the production of images of *solid forms*, which has been recently devised by the same ingenious contriver. If a piece of metal, bent to the contour of one side of a vase, be made to revolve rapidly round an axis corresponding with that of the vase, a spectrum of the solid vase will be generated; and if there be fixed on the same axis a rod of glass bent to the contour of one side of a glass shade covering the vase, the spectrum

* See "Quarterly Journal of Microscopical Science," vol. vii. (1859), p. 69.

of such a shade, standing over the spectral vase, is produced by its revolution.*

This persistence of visual impressions has been also turned to account in the scientific investigation of sonorous vibrations. Thus, by throwing a beam of light upon a violin-string set in vibration by a bow, and observing the figure produced by the movement of the bright spot, Dr. Young was able to show that the middle point of the string, instead of merely moving from one side to the other in the same plane, describes various and sometimes very complicated curves, corresponding to different modes of drawing the bow; so that it is probable that the particular quality of tone evoked by different players from the same instrument has reference to the form of the vibrations produced by each. Following up the same line of inquiry, Professor Wheatstone examined the vibrations of elastic rods, fixed at one end, by watching the figures described by the point of light given by the reflection of a beam from a small bead attached to the free extremity of each; and the simple apparatus, termed the *Kaleidophone*, which he contrived for this purpose, is at the same time a beautiful philosophic toy, and an instrument of refined scientific inquiry.

Another of those simple and ingenious devices, in which this great inventor has been so fertile, is a *Photometer*, in which the motion of a reflecting bead gives a luminous figure, which may be a circle, a straight line, or any intermediate ellipse, according to the mode in which it is set on a disk which can be made to rotate round its own centre, whilst itself revolving round another centre. If light fall upon the bead from two lamps, whose relative illuminating power it is desired to determine, two similar figures are produced, in such close juxtaposition, that their relative degrees of brightness may be appreciated with great nicety; and thus, by moving one or the other of the lamps until the two figures exhibit the same degree of brightness, their relative illuminating powers are ascertained by the proportion between the squares of their respective distances from the instrument. When several beads are placed on it instead of one, a most beautiful effect is produced by the multiplication of the luminous figures, which consist of circles, ellipses, and straight lines, intersecting one another in various directions; each figure marking the course of one of the beads, which varies according to its position with reference to the centre of the rotating disk.

* This beautiful little toy, with a variety of devices, is sold by the London Stereoscopic Company, under the name of "The Optic Wonder."

In all the cases hitherto cited, the persistence of the visual impression, after the withdrawal of its source, is marked by the production of a *line*, by the motion of a luminous *point*, or by that of a *surface*, by the motion of a luminous *line;* the duration of the original impression upon any one spot of the retina being almost infinitesimally small. The same principle, however, may be applied in quite an opposite manner. It was long since shown by Professor Wheatstone, that if a wheel in very rapid revolution be illuminated by an Electric discharge, the wheel is momentarily seen as if at rest; and, further, that it is even possible to record this stationary image photographically on a very sensitive surface; the duration of the illumination being so brief, that the wheel does not move in any appreciable degree whilst it lasts. By a calculation based on the actual rate of revolution of a wheel thus seen at rest, it has been shown by Professor Wheatstone that the duration of the luminous discharge does not exceed *one-millionth part* of a second. Now, it has become easy, by means of the Induction-coil, to obtain a succession of electric discharges following each other with such rapidity, that the visual impression left by one shall be continuous with that renewed by the next; and as each momentary impression is that of a *stationary* wheel, a *continuous image* of a wheel at rest is presented to the mind with such definiteness, that the fact of the wheel being really in very rapid rotation seems scarcely conceivable.*

The same result may be brought about by any mechanical arrangement that shall give a succession of glimpses of an object in motion, however rapid, which shall be sufficiently frequent to produce a continuous image; provided that the object be precisely in the same position on each occasion, so that each impression is identical with that which preceded and with that which follows it. Such an arrangement was carried out in an apparatus devised and constructed by the late Mr. Roberts, of Manchester—the celebrated machinist to whose ingenuity we owe the important invention of the "self-acting mule;" and was shown by him to the writer some twenty-five years since. A card (of which an exact copy is given over leaf), being rapidly whirled by a train of wheel-work round the axis A B,† the characters printed on it were blended, to ordinary

* This very beautiful experiment is at present being exhibited at the Polytechnic Institution.

† There is reason to think that the rate of revolution given to the card was considerably overstated; but the interest of the experiment would be precisely the same, whether the card revolved 4000 or 40,000 times in a minute.

view, into an indistinct haze; but when the card was viewed through a small hole to which the eye was applied, a stationary image of it

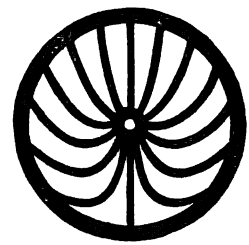
A.— R. Roberts's Machine, which renders objects visible while revolving 40,000 times a minute, was examined by Dr. Dalton, Jan. 9, 1835. —B.

was seen, of sufficient distinctness to allow the printed characters to be read without difficulty. This was brought about by the interposition, between the eye and the card, of a rotating disk having a series of narrow slits at regular intervals, through which alone could the card be seen; the rate of its rotation being so proportioned by the train of wheel-work to that of the revolution of the card, that however rapid the latter might be, the card should always present its full face to the observer at the instant of the passage of one of the slits before the eye. Thus the eye received a succession of instantaneous glimpses of the card; and as its position was exactly the same at each recurrence, an impression was produced of sufficient continuity to give the effect of a stationary image, which was distinct enough to allow the print to be easily read.

Before we proceed to apply the principle which has now been so variously illustrated, to the explanation of the phenomena first brought into notice by Professor Faraday, it is but simple justice to an eminent man, who is now one of the oldest survivors of a past generation of our *savans*, to notice a memoir by Dr. Roget, that appeared as far back as 1825, wherein he calls attention to "a curious optical deception which takes place when a carriage wheel, rolling along the ground, is viewed through the intervals of a series of vertical bars, such as those of a palisade, or of a Venetian window-blind." Under these circumstances, a spectrum is seen of a wheel at rest, of which all the spokes, save those which are seen in the

vertical line, instead of appearing straight, seem to have a considerable degree of curvature; and this curvature progressively increases from the neighbourhood of the upper vertical spoke to that of the lower vertical spoke, as shown in Fig. 1,—the convexity of the curve being always turned downwards on both sides of the wheel, and the direction of their curvature being precisely the same, whether the wheel be moving to the right or to the left of the spectator. "The distinctness of this appearance," says Dr. Roget, "is influenced by several circumstances; but when everything concurs to favour it, the illusion is irresistible, and, from the difficulty of detecting its real cause, is exceedingly striking."

FIG. 1.



Like a true philosopher, Dr. Roget varied the conditions of the experiment, so as to determine what were *essential* and what *non-essential*; and was in this manner led to the determination of its very simple *rationale*. He found that it was essential that there should be a combination of a *progressive* with a *rotatory* motion; thus the spectrum will not be generated, if, while the bars are stationary, the wheel simply revolves on its axis, nor if the wheel simply moves onwards without turning round: but the appearance will be alike produced when the wheel rolls onwards behind the bars, or when the wheel revolves on a fixed axis and the bars are made to move onwards; or when, the bars and the axis of the revolving wheel being alike stationary, the spectator moves onwards, so that the images of the bars and of the spokes which fall upon his retina, change their relative situations, as if one of them moved onwards. It was found that the number of spokes in the *actual* wheel produced no difference in the degree of curvature they exhibit; but that the number of spokes in the *spectral* wheel depends partly upon the number in the actual wheel, partly upon the relative closeness of the vertical bars, and partly upon the rate of horizontal progress in the wheel. If the experiment be tried with a disk which, instead of being marked by several radiating lines, has only one radius drawn upon it, the spectrum shows a number of radii, each curved as in the figure; the number being that of the intervals between the bars which have been passed in one revolution of the wheel. If, on the other hand, a disk with several radii be employed, and the intervals between the vertical apertures are made to corres-

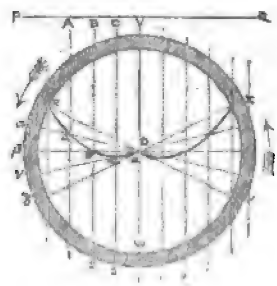
pond with the distances between the spokes at the circumference of the wheel, the images produced by the successive apertures will coalesce, so that the number of spokes in the spectral wheel is not augmented, but their distinctness is proportionally increased. But if the apertures between the vertical bars are made closer, the number of radii in the spectral wheel is increased, and their distinctness is proportionally diminished. The same result will happen if the wheel be made to move onwards more rapidly than it rolls; for the number of vertical apertures which it will pass in one revolution will then be augmented, just as if the apertures were themselves closer. If the bars, instead of being vertical, be inclined to the horizon, the same general appearances result; but the spokes of no apparent curvature are now those which occupy positions parallel to the bars. If, however, the bars be horizontal, and the onward movement either of the bars or the wheel be in the same direction, no spectrum whatever is produced; and, if the inclination of the bars be so considerable as to approach the horizontal, the distinctness of the spectrum is much diminished. But if, on the other hand, a progressive movement in the *vertical* direction be given either to the revolving wheel or to the horizontal bars, a distinct spectrum is produced, as in the first case—its straight spokes being now horizontal.

Lastly, it was noticed that the phenomenon was most distinct, (1) when the intervals between the bars are narrow; (2), when the bars are of a dark colour or shaded, a strong light being thrown upon the wheel; "the deception being further aided by every circumstance which tends to abstract the attention from the bars, and to fix it on the wheel."

The *essential* condition of the phenomenon having thus been found to be the combination of the rotatory movement of a wheel, with its onward motion in a direction contrary to that of the apertures through which it is seen, and the spectrum of a wheel with several radii being found to be producible by the combined rotation and onward movement of a disk with a single radius, the inquiry is so much narrowed, that the illusion can be readily proved to be referable to the principle already explained. This may be best shown by tracing out the succession of glimpses that we receive of a single radius O R (Fig. 2) in a disk revolving upon a fixed axis, through a single narrow vertical aperture that moves horizontally in the direction P Q, at a rate equal to that of the rotatory motion of the circumference of the disk. It is obvious that if, at the time of the transit of the aperture, the radius should happen to occupy either of the

vertical positions V O or O W, the whole of it would be seen at once through the aperture in its true position; but if, in the course of its revolution, it reaches the direction O R just at the time that the vertical aperture is opposite to R, the extremity R will be seen in that position, all the rest of the radius being hid. Whilst the radius is turning to *a*, the vertical aperture has moved on to A; and the point *a* of the radius is the only one that can then be seen through it, since at that point only is the radius O *a* intersected by the vertical line A 1. As the radius successively reaches the positions O β, O γ, O δ, the vertical aperture successively reaches the points B, C, V; and the points of the radius which will be successively seen through it are *b*, *c*, and *d*. If these two motions be mathematically combined, the continued intersection of the radius and the vertical is found to generate the curve R *a b c d*; and the like curve will be produced when the radius has passed the perpendicular O W, and is moving from O Y to O Z, whilst the vertical slit continues to advance at the like rate. Thus, then, by the temporary persistence of the impression left by each of the points of the revolving radius, as it is seen through the succession of apertures, the series of impressions is mentally combined into a curved line; and if the revolution of the disk be sufficiently rapid, the image of that curve remains impressed on the visual sense, until renewed by the recurrence of the same impressions. And it is obvious that, if either the apertures or the radii, or both apertures and radii, be multiplied, the same proportion being maintained, the effect will be only to multiply the number of glimpses received, while the intersecting points remain the same; so that the spectrum is increased in vividness, and can be completed by a less rapid rotation without any augmentation in the number of its radii. We see, moreover, why the spectrum is rendered more distinct by *the narrowing of the vertical apertures*; since, as in the preceding case, it is important that each glimpse of the spoke should be as nearly instantaneous as possible, so that the impression which it leaves in each part of its course may, like that given by Electric illumination, represent the object as at rest. —It is interesting to find that thus early in the investigation, Dr. Roget had distinctly noticed the practical importance of this point,

FIG. 2.



which we shall find to be essential to all the higher developments of the same fundamental principle.

It was about five years after the publication of Dr. Roget's memoir, that Professor Faraday, being at the lead-mills of Messrs. Maltby, had his attention drawn to two cog-wheels which were moving with such velocity, that if the eye were retained immovable, no distinct appearance of cogs in either could be observed; but when he stood in such a position that one wheel appeared behind the other, he immediately perceived the distinct though shadowy resemblance of *cogs moving slowly in one direction.* "Mr. Brunel described to me," he continues, "two small similar wheels at the Thames Tunnel: an endless rope, which passed over and was carried by one of them, immediately returned and passed in the opposite direction over the other, and consequently moved the two wheels in opposite directions with great but equal velocities. When looked at from a particular position, they presented the appearance of *a wheel with immovable radii.*"

The observation was not really as novel as Faraday supposed it to be; for the production of a stationary spectrum by two cog-wheels revolving with equal velocities in contrary directions had been distinctly recorded in 1828 by M. Plateau, who correctly interpreted it on the basis previously laid down by Dr. Roget, to whose memoir he referred. His short notice of the phenomenon (published in Quetelet's "Correspondance Mathématique et Physique," tom. iv., p. 393) seems not to have excited general attention; and there can be no doubt that it was unknown to Professor Faraday, whose interest in the phenomenon witnessed by himself, led him both to devise methods for reproducing it experimentally in various forms, so as, by varying its conditions, to ascertain the influence of each upon the result; and also to investigate the problem theoretically with his usual felicity.

The experimental apparatus which Faraday devised was remarkable alike for its extreme simplicity, and for its varied capabilities. Its foundation consisted of a horizontal board, on which was fixed a vertical board cut out so as to form a central and two lateral supports, as shown in the Plate, Fig. 2. Each of these supports was capped by a little piece of thin copper-plate, bent into such a shape as to form a bearing whereon might rest the extremity of an axis; the middle support having a double bearing, one on either side, and the lateral supports a single bearing. The axes were two small pieces of steel wire, tempered at the extremities; each having upon it a little roller of soft wood, which, though it could be slipped by

force from one part of the axis to the other, still had sufficient friction to carry the axis with it when turned round. To these axes, resting, one on either side of the central support, quite independently on their respective bearings, motion was given by a circular disk of copper; the lower surface of which was covered with a piece of fine sand-paper attached by cement; whilst to the upper was attached a pulley working on an upright spindle fixed into the central support, and capable of being turned either by the hand or by a band connected with a revolving wheel. As this disk, when in place, rested on the rollers of the two axes, its rotation would cause the axes to revolve in opposite directions; and their velocities, which were equal when the rollers were set at equal distances from the centre of the rotating disk, could be made to differ in almost any ratio, by shifting one of the rollers nearer to or farther from that centre. The wheels which were made the subjects of experiment were cut out of cardboard, and were about seven inches in diameter. To the middle of each was attached by cement a little disk, cut off the end of a phial-cork; and a central hole having been made with a needle through both card and cork, the wheels could be slipped on the axis sufficiently tightly to turn with it, and yet loosely enough to be easily removed, so as to admit of the ready exchange of one for another.

When two equal *cog*-wheels, of the form shown in the Plate, Fig. 1, placed on the two axes, were made to move in contrary directions, with equal velocities, and the eye was placed at such a distance in the line of the axes that one wheel was seen superposed on the other, with a dark background behind them, in place of the uniform tint exhibited by a single wheel in rapid revolution, a stationary spectrum of a cog-wheel was distinctly seen. This spectrum, however, was peculiar in two particulars; first, that the number of cogs was double that of the actual wheels; and, second, that the white cogs and the dark intervals between them graduated into each other, instead of being separated by defined lines. When one wheel was made to revolve a little faster than the other, by shifting its wooden roller further from the central support, the spectrum travelled in the direction of the wheel having the greater velocity; its rate of revolution being the *excess* of that velocity above the opposite velocity of the other wheel. And if, instead of employing two wheels with the same number of cogs, one of the wheels had a cog or two more than the other, and both were made to revolve with the same velocity, the spectrum travelled in the direction of the wheel having the greater number of teeth. But if,

again, the wheel having the smaller number of cogs were made to revolve with so much greater a velocity than the other, as would equalize the number of cogs of the two wheels that would pass any given point in a certain time, the spectrum became stationary again.

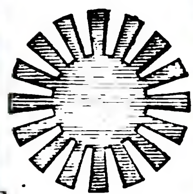
If the wheels were looked at from a point not in the prolonged axis of both, so that one was only in part superposed visually on the other, the effect took place only at that part; and "it was striking and extraordinary," says Faraday, "to observe, as it were, two uniform tints mingling, and instantly breaking out into the alternations of light and shade which I have described."

When *spoke*-wheels were put on the machine instead of cog-wheels, the effect was essentially the same; each wheel giving a perfectly uniform tint when made to revolve by itself, or when looked at obliquely; but a stationary spectrum, having double the number of spokes, being distinctly seen when the eye was so placed that one wheel was visually superposed on the other. Any difference, either in the number of spokes, or in the velocities of the two wheels, caused the spectrum to revolve, as in the cases already described.

The *rationale* of all these phenomena is by no means difficult of comprehension, when the movements of the wheels are studied with reference to the principle already stated, as to the sensible duration of visual impressions; and when we connect with this the principle now rendered familiar by the effects of the Stereoscope; namely, that of the *mental* combination of two or more sets of sensory impressions, which are received either at the same time or in such quick succession as to be continuous.

For the sake of simplicity, it is convenient to examine a case in which the edge only of one cog-wheel is visually superimposed upon that of another travelling in the opposite direction, as shown in the Plate, Fig. 6, in which the continuous line gives the outline of the cogs of the upper wheel travelling from left to right, whilst the dotted line gives the outline of the cogs of the lower wheel travelling with the same velocity from right to left. Now, supposing that the eye be directed towards a point, *l*, of a bright background beyond the cogs, it will be found that this point will be eclipsed by the cogs *a* and *b* simultaneously, for they begin to cover it and they leave it together; whilst, on the other hand, the point *l'* is left uncovered at the same time by the interval between the cogs *a* and *c* of one wheel, and by that between the cogs *b* and *e* of the other. The points *l* and *l'* of the background, therefore, are alternately open-to and shut-from the eye for equal times, since what these

FIG. 1.



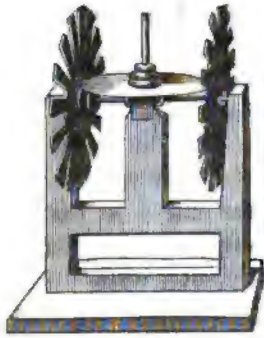


FIG. 2.

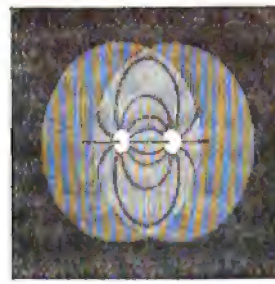


FIG 3.

FIG. 4

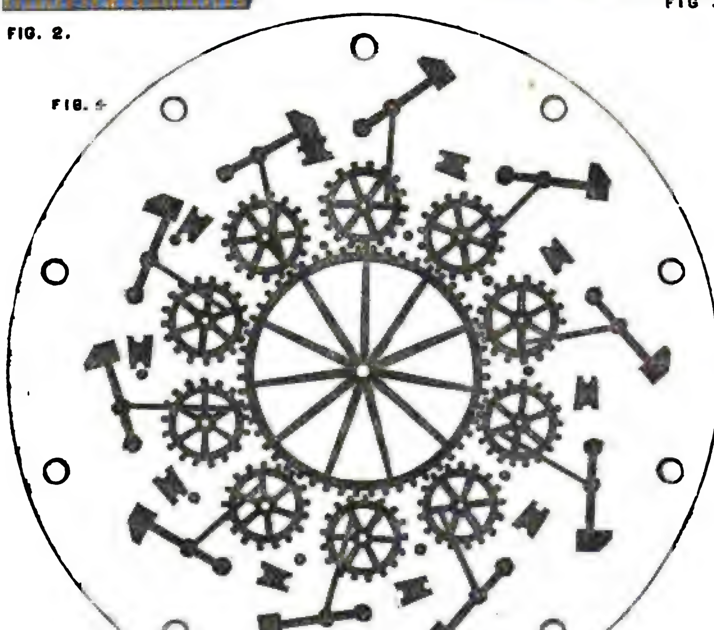


FIG. 5.

FIG. 6.

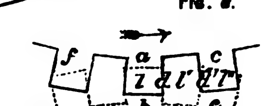
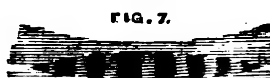


FIG. 7.



cogs do will be done by all the other cogs in turn; half the light, therefore, from those points of the background comes to the eye, and produces a corresponding impression.

But with respect to the intermediate points, *d*, *d′*, the case is different; for, although the cog *b* of the lower wheel is just about to leave *d* exposed, by moving towards the left, the cog *a* of the upper wheel is just about to eclipse it by moving towards the right; and by the time this has passed over it, the cog *e* of the lower wheel has come to *d* from the right, and eclipses it until cog *f* of the upper reaches it from the left. In like manner, while the point *d′* is just being left by the movement of cog *c* of the upper wheel towards the right, it begins to be covered by the movement of cog *e* of the lower wheel towards the left; and by the time this has passed it, the movement of the upper wheel towards the right has brought the foremost edge of cog *a* to impinge upon *d′*, which remains covered by that cog until another cog of the lower wheel comes into the position of *e*. Thus, therefore, the points, *d*, *d′*, of the bright background suffer constant eclipse; and if the wheels be themselves black, those points will show a maximum of darkness. Following out the same method of inquiry, it will be found that the points intermediate between the maxima of light, *l*, *l′*, *l″*, and the maxima of darkness, *d*, *d′*, are eclipsed for intermediate periods, varying as they are nearer to the former or to the latter; and thus a graduated shading-off will be produced between these successive points, giving rise to such a stationary spectrum, formed by an alternation of light and dark spaces, as is represented in Fig. 7. The central light space of this, it will be seen, corresponds to *l*, Fig. 6, the dark space on the right of it to *d*, the next light space to *l′*, the next dark space to *d′*, and so on; the number of alternations of light and dark spaces being double that of the cogs of the wheels.

Adverting to the previous observations of Dr. Roget, Professor Faraday showed how they might be experimentally verified by making one of his wheels rotate behind a strip of card with vertical slits, either the card or the wheel being moved horizontally at the same time; and he also drew attention to a variation in this phenomenon, which is observable when two wheels, revolving in the same direction (as those of a gig), are seen so obliquely that one is only in part projected on the other. A stationary spectrum is then seen, corresponding with that represented in the Plate, Fig. 3; which may be readily reproduced experimentally by cutting a pair of spoke-wheels out of card-board, passing a piece of wire through the centres of both so that they shall be three or four

inches apart, and then making them rotate, by turning the wire between the fingers, in such an oblique position relative to that of the eye, as shall superpose one side of the near wheel on the opposite side of the more remote.

The most important part of Professor Faraday's paper, however, in regard to the subsequent development of his fundamental "idea," is his almost incidental statement, that if *a wheel be made to revolve before a looking-glass, and the image be looked at through the spaces between the cogs or spokes of the actual wheel, a stationary spectrum will be perceived; and this spectrum, instead of having the number of its cogs or spokes doubled, will have the same number as those of the actual wheel.* He did not attempt to explain this phenomenon; the *rationale* of which is by no means obvious, seeing that the actual wheel and its reflected image move in the same, not in opposite directions.

The following is the account given of it by Professor Plateau (Op. Cit., tom. vii., p. 366):—"Every time that a slit passes the eye, it permits the observer to see the image of the disk in the mirror; but in virtue of the narrowness of the slits, this image can only be seen during so small a part of a revolution that it is in effect almost stationary. Now it is evident that the images which thus succeed one another on the retina are perfectly identical, and that, in virtue of the duration of the impressions which they leave, they will produce, if the rate of revolution be sufficiently rapid, a continuous image of the disk, with its radii and its slits apparently motionless." It thus appears that the production of the spectrum depends in this case, not upon the conditions previously investigated by Faraday in the case of the two wheels revolving in opposite directions, but upon the limitation given to the recurring glimpses of the moving object, as in the apparatus of Mr. Roberts; the fundamental principle, however, being the same in both instances.

That Professor Plateau's explanation is the true one—this phenomenon having nothing in common with the production of a stationary spectrum by two wheels revolving near each other in opposite directions, except in so far as both depend upon the persistence of visual impressions—will appear from the following simple experiment which the writer has devised for the sake of putting it to the test. If we look from a distance of two or three feet at a wheel resembling that represented in Fig. 1 (Plate), through another similar wheel held *near the eye*, and both be made to revolve in the *same* direction with equal velocities, a stationary spectrum will be seen having *the same* number of rays as the actual wheel; and the

like result presents itself when the directions of the two revolutions are *opposite*. The effect is improved by narrowing the slits of the nearest wheel; and they may be reduced in number, by closing any of them, without altering the result. In fact, even a single slit will answer the purpose, provided the rate of revolution be rapid enough to allow the successive impressions received through it to produce the effect of a continuous image. Hence it is obvious that the effect is here produced, as in the view of the image of the wheel made to revolve before a mirror, by the mental combination of the series of momentary glimpses which we gain of the entire *back* wheel, as the openings in the *front* wheel pass successively before the eye; and that the stationariness of the spectrum will depend upon the exactness of the correspondence between the relative positions of the rays and of their interspaces in each successive glimpse. As this correspondence must always be precise when the image of the revolving wheel is looked at in a mirror, the resulting spectrum will be *perfectly* stationary; but this *entire* absence of motion in the spectrum can scarcely be attained when the experiment is made with independently-revolving wheels, without a greater perfection in the apparatus for giving motion to them than ordinary workmanship will ensure.—Some further experiments, suggested to the writer by the singular results of the change above described in the relative distances of the eye and the wheels, will be described in a future paper.

It is not a little interesting to find Professor Faraday applying his discovery to the explanation of a phenomenon which was at that time a complete puzzle to Microscopists,—the apparent rotation of the "wheels" of the *Rotifer*, which, even under the imperfect instruments then in use, was so distinct as almost to force the observer to admit their existence as parts of the animal body, although it was not conceivable *how* they could have such a motion, unless detached from it. "It is certain," says Baker, "all appearances are so much on this side the question, that I never met with any who did not, on seeing it, call it a *rotation*; though, from a difficulty concerning how it can be effected, some have imagined they might be deceived. M. Leeuwenhoek also declared them to be *wheels that turn round*." "Notwithstanding," says Faraday, "the evidence adduced by Mr. Baker, which is admitted by some at the present day, it must be evident, from a consideration of the nature of muscular force, and the condition of continuity under which all animals exist, that the rotation cannot really occur. The appearances are altogether so like some of those exhibited in the experiments already described, that I feel no doubt the wheels

must be considered not as having any real existence, but merely as spectra, produced by parts too minute, or else having too great a velocity when in use by the animal, to be themselves recognized. Thus, if that part of the head of the animal were surrounded by fibrillæ, endowed each with muscular power, and projecting on all sides, so as to form a kind of wheel; and if these fibrils were successively moved in a tangential direction rapidly the one way, and more slowly back again, it is evident that currents would be formed in the fluid, of the kind apparently required to bring food to the mouth of the animal; and it is also evident that if the fibrils, either alone or grouped many together, had any power of affecting the sight, so as to be visible, they would be less visible at the part through which they were rapidly moving, than at that through which they were slowly returning; and at that place, therefore, an interval would appear, which would seem to travel round the wheel, in consequence of the successive action of the fibrils."—How true was this sagacious surmise of our great philosopher, is known to every one who now examines the beautiful action of the "wheels" of the Rotifer, with the advantage of superior instruments, and the knowledge derived from the study of Ciliary action elsewhere.

It occurred to the writer, when repeating Professor Faraday's experiments at the time of their first publication, to try the effect of substituting for the hinder wheel, when two were employed, a disk painted in alternate sectors of two colours, corresponding in number with the cogs of the front wheel; and he found, as he expected, that whilst the revolution of this disk blends its colours into a uniform mixed or neutral tint, the interposition of the cog-wheel revolving at the same speed in a contrary direction, gives a spectrum of the disk at rest, with twice the number of coloured sectors, the colours graduating into one another like the lights and shades of the spectral wheel (Fig. 7). Even three or four colours were thus separated, by disposing them in triple or quadruple alternation; the number of sectors of each colour being made equal to that of the cogs of the interposed wheel.

Again, Professor Faraday having mentioned that when the cogs or slits in the wheels are disposed obliquely instead of vertically, and the obliquities have opposite directions, the stationary spectrum has its slits vertical, the writer varied the experiment by giving a considerable circular curvature to the slits; and found that when these curvatures were equal and in opposite directions, the two wheels revolving with the same velocity, the edges of the slits in the stationary spectrum were quite straight. This is not the case,

however, when the experiment is made with a single wheel before a mirror; for the spectrum then represents the actual wheel, whether its slits be vertical, oblique, or curved.

A variation which was very early devised in the experiment with the single wheel before the mirror, is worth mentioning here, as furnishing the key to that forward or backward movement of the figures in the Zoetrope, which is intelligible enough when thus explained, although very puzzling to such as have not grasped the very simple principle to which it is to be referred. If three concentric circles of slits be cut out of a disk, and their numbers be slightly dissimilar—say *eleven* in the innermost, *twelve* in the intervening, and *thirteen* in the outermost—it will be found that as we look at the image in the mirror through one or another of these circles, the appearance of the spectrum will vary. Thus, if we look through the *outermost* circle, that one will be stationary in the spectral wheel; the intervening circle will revolve slowly in a direction contrary to that in which the wheel is actually rotating; and the innermost circle will revolve in the same direction with the preceding, but with twice its rapidity. If we look through the *intervening* circle, that one will appear stationary, while the outer circle will revolve slowly in the direction of the actual revolution, and the inner circle will also revolve slowly, but in the opposite direction. Finally, if we look through the *innermost* circle, that one will appear stationary, the intervening circle will revolve slowly in the direction of the actual revolution, and the outer circle will revolve in the same direction with the preceding, but with twice its rapidity. These results are merely variations of Faraday's original experiment (p. 437), in which one of the two cog-wheels revolving in opposite directions was made to move somewhat faster than the other, or was set with a greater number of cogs;—in either instance the number of cogs of the one wheel which pass before the eye in a given time being greater than the number of those of the other wheel passing in the same time, and the motion of the spectral wheel representing that difference. When we look at the image of the revolving wheel in the mirror, the spectra of the circles that have a *greater* number of slits than that through which we are looking, revolve *forwards* (or in the direction of the actual revolution), while those having a *less* number move *backwards* (or in the reverse direction); their rates of revolution being proportional to the numerical ratio between *their* slits and those of the circle through which we see them.

(*To be continued.*)

WOMANKIND:

IN ALL AGES OF WESTERN EUROPE.

BY THOMAS WRIGHT, F.S.A.

CHAPTER IV.—(*Continued.*)

THE ANGLO-SAXON WOMEN.

It is curious that Aldhelm and the other writers of that class, say nothing of this practice of dyeing the hair, though they accuse the ladies of curling it and of painting their cheeks. Perhaps, however, these Anglo-Saxon Latin writers were applying to their countrymen and countrywomen the denunciations of the southern ecclesiastics of Gaul and Italy. They seem to have overlooked a little what was going on at home, and they may have thought only worthy of condemnation that which they found condemned by authorities nearer Rome; or, perhaps, they had a taste for blue hair. At all events, the existence of blue hair is not alluded to by the Anglo-Saxon writers, whether in their own vernacular tongue or in Latin. But, among the Anglo-Saxon, as among the Franks, the hair was an object of great importance. In earlier times, the cutting of the hair in either sex indicated slavery, or crime which merited the severest punishment. Even down to the present day, the condemned criminal has the head shaved. Among the Anglo-Saxons, long and loose hair in the female sex was typical of freedom and of pure virginity. Hence, in earlier Anglo-Saxon times, an unmarried girl was obliged to wear her hair in this condition. The only indulgence was, that, after a certain age, she was allowed to plait it. On her wedding-day she unplaited it, and threw it loose and scattered over her shoulders, because this indicated her nobleness of birth as well as her virginity. After the marriage, however, the woman's hair was cut short, to show that she had accepted a position of servitude towards her husband; but, as civilization developed itself, this degrading part of the marriage ceremony was dispensed with, and brides were only required after the ceremony to bind their hair in folds round the head. Loose hair continued to be the distinction of an unmarried girl, while a married woman was known by her hair being bound up. Even this distinction seems to have been kept up in practice till a very recent period.

There is a part of the costume to which I have not yet alluded, the shoe. There appears to have been among the Anglo-Saxons no

difference between the shoe (*sceo*) of the two sexes; both are usually represented black, though at times various colours are introduced; and both are represented as rising to the ankle, as having an opening down the instep, and as fastened at the top by a thong (*sceo-þwang*). This form of shoe was, in all probability, derived from the Romans, as it is exactly that of the Roman shoes procured by Mr. Roach Smith from excavations in London.* Among princes and nobles, and especially among the higher ecclesiastics, the upper leather appears, among the Franks and among the Anglo-Saxons, to have been often stamped or punched with elegant patterns similar to those of the shoes described by Mr. Smith. Perhaps, also, the soles of the shoes were studded with nails like those of the Romans, for we find in the Anglo-Saxon glosses the word *sceo-nægel*, a shoe-nail.

The men among the Anglo-Saxons certainly wore stockings, and there can be little doubt that they were worn by the women also; we know nothing of the material of which they were made; but that of the men appears from the illuminations of the time to have been of different colours. The Anglo-Saxons also wore gloves, for the word (*glóf* in Anglo-Saxon, and *glófi* in Old Norse) belongs to the Anglo-Saxon and Northern languages. We trace them on the hands of ladies in one or two instances in the drawings of Anglo-Saxon manuscripts, but the word itself cannot have been of very common use, for we find, especially in the older writers, that, instead of using the correct names, they speak of the glove by the rather singular name of a hand-shoe (*hand-sceo*).† It has been remarked by some of our writers on costume, that the Anglo-Saxons never went without shoes; that even labourers, though generally represented as bare-legged, are not represented bare-footed. This, however, is not strictly correct; at least as applied to the female sex. The party of gossips in the accompanying cut, taken from the Harleian Manuscript, No. 603, already described (fol. 12, r°), are

ANGLO-SAXON GOSSIPS.

* Descriptions with engravings of these Roman shoes, which are now in the British Museum, will be found in Roach Smith's "Illustrations of Roman London."

† The first gloves among the Germans and Scandinavians appear to have been warlike implements, things fitted upon the hands with which you could scratch and tear in a very destructive manner.

bare-footed as well as bare-legged, and the infants they carry in their arms are entirely naked. No doubt they belong to the lower classes of society. In our last cut (page 356), we have seen a woman leading by the hand a child of a more advanced age, who is similarly naked. These examples would seem to show that, among the lower orders of Anglo-Saxon society, the children were allowed to go naked until the age when they could be left to walk about by themselves.

As stated before, the wife, though above all the rest of the family, was inferior to and dependent upon her husband. He was the sole possessor, and everything in the house originated from him. If he made war, the spoils taken from the enemy, as far as his followers were concerned, belonged to him, and he distributed them among his warriors. The duty of distributing his gifts appears to have been considered to belong to his wife, and was performed at the great feasts. Then the chieftain's wife, the lady of the household, from time to time, rose from her seat and crossed the hall, and not only served the ale or mead to the guests, but delivered to them the presents destined for them by her husband; and in this she was assisted by her daughters, or by some other noble females attached to her person. In the poem of Beowulf, Hrothgar's queen is represented as performing this office :—

Hwílum mæru cwén,	At times the great queen,
friðu-sibb folca,	the peace-tie of peoples,
flet eall geond-hwearf,	all traversed the hall,
bædde byras geonge;	her young sons addressed;
oft hió beáh-wriðan	often she a ringed wreath
secge sealde,	gave to the warrior,
ær híe to setle gong.	before she returned to her seat.
Hwílum for duguðe	At times before the nobles
dóhtor Hróðgáres	Hrothgar's daughter
eorlum on ende	to the earls in order
ealu-wæge bær,	bore the ale-cup,
þa ic Freáware	whom I Freáware
flet-sittende	the court residents
nemnan hyrde,	heard name,
þær hió gled-sinc	where she bright treasure
hæleþum sealde.	gave to the warriors.

"Beowulf," l. 4038.

On reading this, we more fully understand the force of the passage of the Gnomic Poem in the Exeter Book, which tells how an earl's

wife—earl was the title assumed by the head of the family—was usually beloved of her people:—

And wif geþeon,	and his wife (shall) flourish,
lof mid hyre leodum,	beloved with her people,
leoht-mod wesan.	be of cheerful mind.

Thorpe's "Codex Exoniensis," p. 338.

If the head of the family had store of bread, it showed that he possessed broad lands, and that he cultivated them. There were three words in the Anglo-Saxon language, which indicated, almost poetically, the position of the different parts of the family towards each other. The chieftain himself was called the *hlaf-ord*, the origin or source of the bread, he to whom it belonged; his wife was the *hlaf-dig*, the distributor of the bread; his retainers and his servants, and all who lived at his table, were called *hlaf-ætas*, eaters of the bread. The two former words, *hlaford* and *hlafdig* gradually took a nobler place in our language, and are now represented by the well-known words *lord* and *lady*.

It has been supposed that it was only towards the tenth century that the women of the household gained the right of sitting at table with the men, and that this is evidence of a great advance in their social position. This, however, may be an assumption founded too hastily upon our mere want of knowledge. We must bear in mind that the dinners described by the poets and other early writers are usually great feasts, more or less of a ceremonial character. The guests seem not generally to have taken their ladies with them, and the ladies of the household who were worthy to accompany their chief and his lady were few in number; and it is not stated by the writers who describe these scenes that they were not in the hall. I have shown, in a previous chapter (STUDENT, No. III., p. 172), that, according to the ideas of the Scandinavian mythology, the gods and goddesses sate together in hall, without any distinction. We find several pictures of table-scenes in the later Anglo-Saxon manuscripts, of which we give one in the accompanying cut. It is taken from the manuscript of Alfric's translation of Genesis (MS. Cotton., Claudius, B. IV., fol. 36, v°), where it is intended to represent the feast given by Abraham on the occasion of the birth of his child. The guests are seated at a long table, and are in the act of drinking from the ale-cups, and pledging each other. It will be seen that men and women are here mixed together without any order, the latter distinguished by having their heads always covered with the head-rail.

It may be doubted, indeed, whether this picture of the two sexes sitting together indiscriminately at table be a proof of

ANGLO-SAXON LADIES AT TABLE.

an improvement in woman's position in society; but there can be no doubt, that for this improvement she was indebted in a great measure to the interference of the Christian clergy. They laboured to destroy, or at least to diminish, the old patriarchal spirit, and to emancipate the female sex from the too great authority of fathers and husbands. Some old customs were abolished at an early period after the introduction of Christianity. Among these was polygamy, which certainly existed among some branches of the German race, and which we have seen was practised among the gods of Scandinavian fable. There can hardly be a doubt of its existence among the Anglo-Saxons, at least in their earlier times, because at a later period we find it forbidden by law. One of the code of laws of the Northumbrian priests prohibits, "with God's prohibitions, that any man have more wives than one."* This prohibition, it will be remarked, belongs to the ecclesiastical law; it is not found in the secular laws. It appears to have been the usual custom throughout the Germanic race, when a head of a family died, leaving a wife by a second marriage, that the son and heir married his step-mother. Perhaps she was considered as a part of the father's property, and therefore of the son's heritage. This practice was proscribed by the Church. Ethelbert, King of Kent, the first Anglo-Saxon king who embraced Christianity, took a second wife after the death of his first queen, the Frankish princess, Bertha. His son, Eadbald, was in his heart

* "Ancient Laws and Institutes of England," vol. ii., p. 301.

opposed to the new faith. When Ethelbert died, in 616, and Eadbald succeeded to the throne, the latter at once rejected Christianity, and, returning to the customs of his ancestors, married his father's widow. The well-known miracle by which King Eadbald was converted and reformed is related by Bede, who tells that he "abjured the worship of idols, and renounced his unlawful marriage"—unlawful, of course, only under the ecclesiastical laws. At a later date, Ethelwulf, King of Wessex, the father of Alfred, in his old age took for his second wife Judith, the daughter of Charles the Bald, of France. On his death, in the year following (857), his son Ethelbald, who succeeded him, married his widow, Judith. The clergy were indignant, and Swithun, Bishop of Winchester, persuaded him to separate himself from her.

(*To be continued.*)

STEIN ON THE INFUSORIA.—BOUNDARIES OF THE GROUP.

THE second part of Dr. Friederich Stein's great work on the organization of Infusoria, "Der Organismus der Infusionsthiere," contains a great mass of important matter. We propose, from time to time, to lay some of his principal facts, observations, and theories, before our readers.

Referring to the classification of Infusoria, he recites Lachmann's observations on the outward openings of the contractile vesicles of an Acineta which he discovered on a water-beetle, and observes that Lachmann rightly concluded that these organs are not to be regarded as heart-like centres of a circulatory system, but as excretory organs. Lachmann differed afterwards from the opinion of his friend Claparède, and wished to replace the Rhizopod-Infusoria in the class of Infusoria. The only definite reason for this course (with which Joh. Müller coincides) is, that the Rhizopod-Infusoria possess, like all real Infusoria, contractile vessels; but the undoubted Rhizopods do not possess them. It is not clear why this reason—the correctness of which is not at all yet decided—should be made thus decisive, as it is opposed by an equally important one, which, in an equal degree, demands and justifies the connection of the Rhizopod-Infusoria with the other Rhizopods, namely, that all real Infusoria move by means of cilia; but that, on the contrary, the Rhizopod-Infusoria move, like all other Rhizopods, by means of pseudopodia. All the rest of their organization, and especially their

manner of taking food, and the rejection of the indigestible remains, speaks clear enough for the connection of the Rhizopod-Infusoria with the true Rhizopods. The Infusoria which take solid food, and which are certainly the greater number, possess always on invariable parts of the body a mouth and an anus; the Rhizopods and Rhizopod-Infusoria, on the contrary, are able to take in and excrete solid matter at all parts of the surface of their bodies, or, at any rate, throughout a larger or smaller portion of their surface; but in no case has a real mouth or anus been discovered.

Even the Acinetans, who do not possess a real mouth or anus, stand, as regards taking food, in a totally different relation to the Rhizopod-Infusoria, and these latter could, were they to be arranged with the Infusoria, only be placed between the Acinetans, and the Flagellate-Infusoria, because the Acinetans take only fluid food with the widened points of their suckers. And then would it be possible to separate animals who are in most regards so similar to each other as the genus Euglypha, Duj.; Cyphoderia, Schlumb. (Lagynis, Schultze), Trinema, Duj.; and Coryzia, Duj., on one side, and the genus Gromia on the other, without a violation of nature? Therefore it is not to be doubted that Rhizopod-Infusoria are to be ranked with the class of the Rhizopods.

E. Haeckel also defends this position in his masterly Monograph of the Radiolaria. On the other hand it seems to him indeed as if the Rhizopod-Infusoria formed a thoroughly distinct division of organisms, sharply opposed to the general mass of all the other Rhizopods, there being no possibility as yet of placing them in a systematical position, as their animal nature is even not yet sufficiently settled. It would be conceivable to doubt the animal nature of the Amœbæ,* considering the facts known with regard to the Myxomicetes; but it appears very strange that Haeckel raises also doubts concerning the animal nature of the Arcellinæ, in which he differs from all hitherto received opinions. Proceeding from a theoretical point of view, Haeckel has arrived at very singular notions concerning the limits between the animal and vegetable kingdoms which should have aroused his misgivings with regard to the principles from which he took his departure, as they are in contradiction to the results of all the modern researches on Infusoria. In fact, Haeckel comprises in the class of the Infusoria only my orders of the Peritrichal,† Hypotrichal, Heterotrichal, and Holotrichal

* Dr. Wallich's researches are quite sufficient to decide the animal nature of the Amœbæ.—Ed.

† For explanation of these divisions see STUDENT for May.—Ed.

Infusoria, which he recognizes as natural, and the Acinetans; but all the Flaggellate Infusoria he banishes to the vegetable kingdom. Of the reasons for assuming the animal nature of the Flagellate Infusoria given in the first part of my work, Haeckel has taken no notice at all. It only remained doubtful whether the Volvocinæ* appertained to the animal kingdom; but all the other Flagellate Infusoria are recognized by the general assent of investigators as decided animals.

Claparède and Lachmann differ also considerably from the hitherto prevailing view concerning the position in which the Infusoria are to be placed in the animal kingdom, I am opposed to their opinion. They do not deny that the Infusoria belong to the simplest animal organisms; but, notwithstanding this, they will not class them in a distinct group of the Protozoa at the end of the animal kingdom; they maintain the opinion that they are most closely connected with the preceding animal groups, and should be subordinated to them. They affirm, especially, such an unquestionable analogy between the Infusoria on one hand, and the Polyps and Acalephs, or Leuckart's Cœlenterates on the other, that they think themselves forced to consider the Infusoria only as a simple subdivision of the Cœlenterates.

This paradoxical view finds support principally in Claparède and Lachmann's equally erroneous opinion of the composition of the body of Infusoria, as given by Lachmann on page 58 of the first part of his essay, affirming that the body of the Infusoria consists, on its outmost layer, and to a very slight depth only, of real contractile parenchyma, and that the whole interior is filled with chyme, and the food taken into the digestive cavity which communicates with the exterior, either through the mouth, or through a tube leading from it.

There certainly would be a remarkable analogy between the Cœlenterates and the Infusoria if this opinion were correct, as it is one of the chief features of the Cœlenterates, that their mouth leads directly into a very large general cavity of the body, or into a larger or shorter tube, ending in that cavity.

But to this analogy it is impossible to attach much value; and also it is inapplicable to a considerable number of the Infusoria: namely, the mouthless Opalinæ and Acinetans. Moreover, the tube following the mouth represents, in such Cœlenterates as possess it, the real digestive organ, while with the Infusoria it represents only the œsophagal canal.

* This is no longer doubtful.—Ed.

This presumed analogy loses still more value when we consider how totally different is the remaining organization of the Cœlenterates from that of the Infusoria. The Cœlenterates exhibit a radiate arrangement of their parts, while the greater number of the Infusoria are bilateral animals. The Cœlenterates do not possess an anus; the Infusoria commonly have one. Further, the body cavity of all the Cœlenterates provided with an intestinal tube (the Polyps) is divided by radial partitions into compartments; the Infusoria, on the contrary, have nothing analogous to this, and even the true limits of their supposed body cavity can not be determined with certainty; while the body cavity of all the Cœlenterates is lined by a proper epithelium, and consequently always forms a sharply-defined space. The most essential and characteristic organs of the Infusoria are the nucleus and the system of the contractile vessels, and the Cœlenterates have nothing analogous to these. Finally, there is a most important morphological character, which forms a fundamental division between the Infusoria and the Cœlenterates, and makes all alliance between those two classes of animals impossible; viz., the body of the Cœlenterates is formed of cells, originating out of the division of the impregnated yolk. It may therefore be regarded as an aggregation of cells. But the body of the Infusoria is developed from a single cell, which only enlarges and alters into various shapes. Consequently there are always cells or nuclei visible in the body tissue of Cœlenterates, which originated from the metamorphosis of cells. But this is not the case with the Infusoria; their body tissue consists of a certainly not indistinct, but still always homogeneous and structureless substance, "the sarcode," of which we shall speak by and by.*

Agreeing with Claparède and Lachmann, I formerly took for granted that the Infusoria were provided with a digestive cavity; but, notwithstanding this, I never could find any relation between Cœlenterates and Infusoria which would justify ascribing to the latter the organization-plan of the Cœlenterates. Now, I still adhere to my first opinion, that the body of the Infusoria consists throughout entirely of sarcode, and that the body cavity filled with chyme is nothing else than an inner tissue formed of softer and yielding sarcode. The inner tissue passes very gradually outwards into the investing tissue, consisting of a tougher and more resisting sarcode, and covered on its outer surface by the cuticle which Claparède and Lachmann regard as the only body tissue. I consequently believe in no relation at all, or near connection, between

* Are these distinctions as clear and precise as Stein asserts?—Ed.

the Cœlenterates and the Infusoria, and in my opinion no course is possible but to regard the Protozoa as a special group.

Within this group the Infusoria have to all appearance their place, and it cannot be denied that they comprise the simplest animal organisms. The Infusoria are joined immediately by the Rhizopods, with which I associate the Gregarines, and which form a separate order. Such an unmistakably close relation exists between the Amœbæ (whose connection with the Rhizopods I take for granted) and the simplest forms of Gregarines (as contained in my genus Monocystis), that it seems to me impossible to place animals that are so similar in their organization and vital actions in different classes of the animal kingdom.

GLOBULAR CLUSTERS OF STARS.

BY REV. T. W. WEBB, M.A., F.R.A.S.

Few objects in the sidereal heavens are more interesting than the compressed masses of minute stars with which they are studded at irregular intervals, and which are known among astronomers by the name of "globular clusters." By far the greater part of these are only perceptible with telescopic aid, the keen-sighted Argelander having reckoned as visible without it, that is in northern Europe, only three properly so-called, two in the constellation Hercules, and one in Pegasus; though he enumerates fifteen "cumuli" or heaps of stars, which at a greater distance from us would assume a somewhat similar aspect. These objects hold an intermediate position, to our sight, between the more conspicuous groups in which bright stars, though evidently connected, are sprinkled pretty widely over the telescopic field, and the nebulæ, more properly so called, whose stellar nature, where it is distinguishable at all, is only developed by the most powerful instruments and under the most favourable circumstances. The term "nebula" in fact has undergone a process of retrogradation during the advance of science. In the ancient catalogues, "stella nebulosa" signified merely the misty aspect sometimes presented to the naked eye by a group of a few minute and indistinctly-seen stars—such, for instance, as that in the head of Orion—while, strange to say, some real and conspicuous nebulæ, those in the sword of Orion and the girdle of Andromeda, were entirely ignored. The introduction of the telescope, by exhibiting at once the composition of these specks, naturally displaced the

term, and fixed it on a much more numerous class of groups and assemblages visible only with its aid, and from the inadequacy of that aid presenting a hazy appearance. The increase of optical power in resolving the easier of these into open clusters, drove the term still further back into the depths of space; and now, though many of the ancient "nebulæ" of Messier's catalogue in 1783, like the lunar "seas," are indulged in common parlance by the retention of their antiquated title, in a more accurate classification they would be rated merely as "telescopic clusters," while the term "nebula" would be appropriated to objects which, even when examined with all the appliances of modern optical skill, are still characterized by a truly nebulous or cloudy indistinctness of aspect. These latter, indeed, belong to at least two perfectly dissimilar classes; and if the spectroscope could ever be rendered delicate enough to deal with all that the telescope can show, they would be ranked according to their true nature, the "continuous spectrum," or uninterrupted prismatic image, indicating the presence of stars so remote as to be separately undistinguishable, as the "gaseous spectrum," or image in which only a few bright bands appear, denotes that vaporous state to which alone in strictness the term "nebula" corresponds. At present, however, the latter name is indiscriminately given to every object whose hazy indistinctness conceals its real character. Between these and the more or less scattered groups, which, interesting and beautiful as they may be in the telescope, possess little definiteness of arrangement, intervenes the class of "globular clusters." They are not, indeed, marked off by any sharp boundary, especially on the hither side; the scattered sprinkle passing through a progressive series imperceptibly into the symmetrical cluster. But there is, nevertheless, as in many similar cases, quite sufficient individuality to constitute a separate order, though it is not easy to fix its precise beginning. Of these Sir J. Herschel has enumerated 111 in his "General Catalogue of Nebulæ and Clusters of Stars," published in the Philosophical Transactions for 1864—a noble work, which is never likely to be superseded, although, of course, the great Melbourne reflector and similar instruments may be expected to add to its contents. And it is on some of the peculiar characteristics of such clusters that we are going to offer a few remarks.

To the careless observer there may be little that is attractive in the first sight of a globular cluster in an ordinary telescope—a spot of dull foggy light, or at best a collection of minute and insignificant stars. But spectators of this class are not needed;

science can well dispense with them; their absence will never be felt at the eye-piece, unless, indeed, they come, as some of them may, to be awakened to more genuine curiosity and more earnest thought. To the attentive and intelligent eye, these misty specks or sparkling patches will disclose scenes of ever-increasing wonder, and for those who have access to instruments of varied aperture and power, it offers an interesting and instructive comparison to follow one of these clusters in its progressive "resolution," or separation into its component individuals. We may make choice for this purpose of one of the finest of them, that formerly called "the nebula in *Hercules*," No. 13 of Messier's Catalogue, commonly abbreviated into M 13, or 4230 of the "General Catalogue." This is easily found by drawing a line from *Wega* to *Gemma*, the brilliant in the Northern Crown; somewhat nearer to the latter than the former star this line will pass between two 3 mag. stars lying in a sloping direction at some distance on either side of it, ζ *Herculis* (the brighter) below, and η above; in a line between these two, but about one-third of the distance from η, the cluster is situated. Halley, who was the discoverer in 1714, says of it, "This is but a little patch, but it shows itself to the naked eye when the sky is serene and the moon absent." Thus seen, however, it will be too minute to give any idea of its nature. Direct to it the smallest telescope, even an ordinary finder, and it will be drawn out into a foggy speck; 2 or 2½ inches of aperture will render it a conspicuous object; with about 4 inches the lower powers will show a beautiful lucid "ball of wool," brightening towards the centre, while higher magnifying will readily give twinkling points in the mass, that at once declare its character. Larger apertures will gradually bring more and more stars out of the cloud, and show it surrounded by a retinue of straggling attendants or "outliers," as they are termed; but the interior, though sparkling, and obviously starry, will remain condensed into such a "blaze," or continuity of light, as still (in connection with an interspersed multitude of the minutest points) to convey the impression of nebulosity; till, in the grasp of the largest reflectors, all remaining indistinctness is dissipated, the resolution is entire, the confusion of the crowd is pierced through, and the individuals stand insulated, in their countless thousands, upon the darkness of the heavens.

This, however, is one of the most favourable instances. In many others the process is less complete; we have to begin with an object undiscoverable by the naked eye, and leave it still imperfectly resolved with our utmost power, though its sparkling

or "granulated" aspect admits of no doubt that the deficiency lies merely in our instrument. Throughout the whole series, with a general uniformity of composition, we shall meet with abundance of individual diversity. In some cases the components are less crowded, and therefore of easier resolution; in others, though they may be separately brighter, and, so far, more distinguishable, they form, from apparent contiguity, a more intractable central blaze, or possibly a kind of nucleus—a phenomenon not unknown even in nebulæ of otherwise very feeble luminosity: the varieties, in short, of aspect are too numerous to be particularly described; the selection, however, of a few prominent characteristics may be of some interest to the reader, and more especially to the student who intends to make personal acquaintance with these strange occupants of distant space.

First, then, we shall draw attention to their *insulation*. This is not an invariable distinction of clusters, many of them seeming to be aggregations of thickly crowded strata of stars, such, for example, as constitute the ground of the Milky Way, round local centres of attraction. A very fine instance of one of these galaxy clusters is H VII. 12 (that is, No. 12 in Sir W. Herschel's 7th class), R. A. 7h. 12m. D. S. 15° 24′, in *Canis Major*, easily found a little more than 3° *f* γ, 4 mag.—the more easterly of the two tolerably bright attendants between which *Sirius* stands. Another, H VI. 30, R.A., 23h. 51m. D. N. 56°, in *Cassiopea*, is a splendid mass as viewed with a large aperture; lying about 2½° S. of β (the westernmost star of the great W) and somewhat *p*. Neither of these is classed as a globular cluster in the "General Catalogue," in which they stand 1512 and 5031, but they are mentioned here both as beautiful objects for the student, and as exemplifications of the fact that local concentration is occasionally to be met with in extended strata. Such, indeed, Sir John Herschel tells us, is especially the case even with regular globular clusters in a portion of the galaxy traversing the constellations *Sagittarius, Scorpio, Telescopium*, and *Ara*, and, though of course some instances might be due to mere optical superposition, yet in others he sees strong evidence of actual connection. But in that northern hemisphere with which we are more familiar, insulation is the general rule; though we shall not find in our own skies so striking an instance of it as that of the southern 47 *Toucani*, "a most glorious globular cluster . . . . a stupendous object," according to Sir J. Herschel, which, he says, is *completely insulated*, so that after it has passed through the field, "the ground of the sky is perfectly black throughout the

whole breadth of the sweep." This splendid mass, measuring with the stragglers 15′ or more, is so visible to the naked eye that Humboldt, on his arrival in Peru, mistook it during several evenings for a comet. In this imposing way these clusters stand out by themselves—distinct and separate families, or rather tribes, of hundreds and thousands of individuals, all so drawn into a compacted mass, that the bond of union on the one hand, and the segregation from the rest of the universe on the other, are obvious at a glance. There is something marvellously strange in the aspect of such a glittering ball—an island in the unmeasurable ocean of space; and not less remarkable, doubtless, must be its unknown destiny in the counsels of the Creator.

The numbers, again, thus gathered into one separate mass are even more surprising than their disconnection from other systems. Arago may have exceeded the truth in estimating them in some instances at as many as 20,000; and the first impression of extreme number is often a deception, which the process of counting, when practicable, dispels. But Sir J. Herschel, a witness of the most enlarged experience and unimpeachable accuracy, assures us that "on a rough calculation, grounded on the apparent intervals between them at the borders, and the angular diameter of the whole group, it would appear that many clusters of this description must contain at least 5000 stars, compacted and wedged together in a round space whose angular diameter does not exceed 8 or 10 minutes."

The insulation, of which we have spoken, does not, however, imply a definite boundary. On the contrary, these clusters are usually, as has been said, environed by a straggling retinue, whose relation to the interior mass in point of magnitude and position is sufficiently marked to preclude the idea of mere optical coincidence. One cluster in the S. hemisphere (Gen. Cat. 4372) is mentioned as having a scattered train extending all round to three times its diameter, and dying away very gradually.—This external diffusion is balanced, on the other hand, by a varying but usually considerable degree of central compression. It is obvious that if the components are arranged at equal distances throughout, the interior must on optical grounds appear more thronged than the edges, and this no doubt may sometimes be the sole cause of the brightening there. As Arago has, however, observed, such a constitution would produce a rapid dilution at the circumference, and a very slow increase towards the centre; while the ordinary aspect, being the reverse of this, indicates an actual and not merely an optical com-

pression. This, in fact, is in many instances so rapid and dense that unless the magnitude of the components is augmented, their mutual distances must diminish, towards the heart of the mass. That the latter is the preferable explanation of cases of irresolvable "blaze" is rendered probable by the corresponding appearance of resolvable ones when the power is insufficient to break them up. The increase of density is sometimes so rapid in a limited space as to give the impression of an actual brilliant nucleus of some kind, which nevertheless is probably, as far as starry clusters are concerned, an optical illusion, though in gaseous nebulæ it may be otherwise. In fact, these clusters are almost universally characterized by the absence of any very rapid inequality of associated magnitude. There is among them not only a wide range of magnitudes, where pretty equal, from about the 10th (M. 12. Gen. Cat. 4238, R. A. 16h. 40m. D. S. 1° 42′ in *Ophiuchus*) to the 18th (Gen. Cat. 4332, R. A. 17h. 41m. D. S. 37°) of H. (Sir J. Herschel)'s scale, or 9th to 11th mag. of Σ(W. Struve)'s; but also in individual clusters, as in the great cluster in *Hercules*, from the 11th to the 20th, that is, the smallest visible in an 18½-inch front-view reflector. But anything like a sudden *jump*, if we may so express it, from comparatively great to very feeble luminosity is quite exceptional.

Two very interesting cases, indeed, of this nature deserve to be mentioned, though neither of them globular clusters, nor within European vision. One close group (4746 of H.'s Double Stars in Cape Observations) of 1½′ diam. consists of an 8 mag. star surrounded by a dozen of 12 or 13 m.: another group (4962) is composed of a 6½ m. star with 15 or 20 stars of 13 m. clustering round it. We may also allude to the marvellous instance of M. 80 (Gen. Cat. 4173), R. A. 16h. 9m. D. S. 22° 40′ in *Scorpio*, described by H. as a magnificent very bright large globular cluster, very much brighter in the middle, well resolved into stars 14 m.,—nearly in the centre of which a star of 6½ or 7 m. very suddenly appeared between May 18 and 21, 1860, and had almost faded by June 10. But this was probably a case of mere optical coincidence; and the previous two might possibly be nothing more.

As a rule, then, the democratic rather than monarchical constitution of these starry nations is evident. Not that, any more than in terrestrial states, real equality is often met with. H., indeed, at the Cape, occasionally came across clusters, and some globular ones, in which the magnitudes were remarkably equable; but a gradual subordination of several ranks is customary, and in some instances

it is carried out in a very singular way. We may take for an example the cluster in the S. hemisphere known as *ω Centauri*, "very conspicuous to the naked eye as a dim cometic-looking star," 4 or 5 m.—a "truly astonishing object," of which the great observer has given a beautiful and surprising representation. In this cluster, "beyond all comparison the richest and largest object of the kind in the heavens," and having a diameter of full 20′ or $\frac{2}{3}$ that of the moon, "there must be thousands of stars:" near the centre there are two distinct darkish spaces. The resolution with H.'s reflector was complete into stars of two mags., 12 and 13, "without greater or less, and the larger stars form rings like lace-work on it." He subsequently says, from a great many inspections, that he inclines to attribute the appearance of two sizes to little groups and knots of stars of the smaller size, lying so nearly in the same visual line as to run together by the aberrations of the eye and telescope, and not to a real inequality; and this explanation of an appearance often noticed in such clusters is corroborated in this instance by the distribution of these apparently larger stars in rings or mesh-like patterns, chiefly about the centre where the stars are most crowded.

These expressions seem to admit that the explanation is not universally applicable; and it certainly does not adequately meet such instances as M 13, containing a wide range of magnitudes, or others recorded by the great observer of the southern sky; such as M 22 (G. C. 4424), R. A. 18h. 28m., D. S. 24°, in *Sagittarius*, where 12m. stars are equally scattered over the cluster, but those of 20m. form the central mass:—Cape 3692 (G. C. 4311), "very much compressed in the middle, where, however, the stars are very small, while everywhere else they are 13 m."—Cape 3778 (G. C. 4467) "the stars are of 2 mags., the larger 11 m. run out in lines like crooked radii: the smaller, 16 m., are massed together in and round the middle." And a similar structure may be perceived in the grand clusters of our own hemisphere, M 3 (G. C. 3636) in *Canes Venatici*, M 5 (G. C. 4083) in *Libra*, and M 53 (G. C. 3453) in *Coma Berenices*. The following is a description of the working of a beautiful $9\frac{1}{3}$-inch silvered mirror upon the first of these. "Finely resolved: stars of 2 mags. at least; larger perhaps 9·5 Σ; smaller 10·5. The larger are sprinkled alike through the mass and among the outliers to the very edge. No central blaze, nor increase incompatible with a denser spherical form within a globe of more sparse and irregular character."

Some very remarkable examples may be given of peculiar internal arrangement. H. especially instances 47 *Toucani*, the "most glorious globular cluster" already referred to, as exhibiting "con-

densation in three distinct stages—first very gradually, next pretty suddenly, and finally very suddenly very much brighter in the middle up to a central blaze, ... the stars are all nearly equal (12 . . . 14m.)." But what renders this rapid internal compression the more remarkable is the "rose-coloured light of the interior, and the white of the exterior portions," a fact of which the great observer had no doubt. This singular contrast bears a considerable analogy with another fact pointed out by him, that among irregular clusters, exhibiting no central condensation, "it is no uncommon thing to find a very red star, much brighter than the rest, occupying a conspicuous situation." The stars in globular clusters are usually so minute, that such a distinction of hue would not be perceptible there, or possibly it might be found to be of more frequent and, in proportion, more significant occurrence. A somewhat parallel instance is Cape 3334 (G. C. 2354), which was at first taken to be a red star 10m. in the centre of an excessively condensed group 15 . . . 18m. with a surrounding nebulosity, but which was subsequently pronounced to be, not a star, but perhaps the centre of a very suddenly condensed globular cluster. It is deserving of notice that Secchi often observed a larger and redder star in the centre of the radiating groups, or at the commencement of the spiral arcs, which he found so prevalent among the larger stars in the galaxy.

The mention of these spiral arcs leads us to remark a similar arrangement in the structure of clusters. We have already had an instance in the "crooked radii" of Cape 3778: and H describes M 53 as having "curved appendages, like the short claws of a crab, running out from the main body;" and the great M 13 as having "hairy-looking curvilinear branches." It appears a strange and unaccountable relation that this curved formation should be perfectly similar to that of many gaseous nebulæ, which seem to have so very little in common with these masses of stars. In another particular, however, they may be thought to agree—a tendency to rifts, or linear vacancies. Those discovered by Bond in the Great Nebula of *Andromeda*, and fairly visible with 8 inches of silvered glass, are well known on the one hand; on the other, a parallel may be traced in the "dark lanes" detected by Lord Rosse in the great cluster in *Hercules*.

These remarks might have been easily extended. No notice has been taken of the inquiries that might have been instituted as to their conjectural magnitude and distance, the permanency of their constitution, or the somewhat mysterious indications of spectrum analysis. These may possibly furnish us with subjects of thought at some future opportunity.

THE LICHNOPHORA—MIMETIC INFUSORIA.*

BY PROF. ED. CLAPAREDE.

STEIN has recently separated from the Vorticellina, under the name of Urceolarians, a family of ciliated infusorians, of which he distinguishes three species: *Trichodina*, Chr., *Trichodinopsis*, Clprd. and Lachm., and *Urceolaria*, St. This last genus contains only one species, previously described under the name of *Trichodina mitra*, St., a species for which Stein revived the name *Urceolaria*, already employed by Lamarck and Dujardin for Trichodina and certain other Infusoria. The convenience of erecting the Trichodina into a family apart from the Vorticellians, appears to me indisputable. It is, however, another thing to decide whether the Urceolarian family, as defined by Stein, is natural. The extreme affinity of the genera *Trichodina*, Ehrb., and *Urceolaria*, St., is evident; but the relationship of *Trichodinopsis*, Clpd. and Lachm., with these two genera is open to dispute. Stein observes that Trichodinopsis, with an almost complete clothing of cilia, cannot remain in the smooth family of the Vorticellians, as a ciliated Vorticellian would be a contradiction. In this he is right; but why should not a ciliated Trichodinian be also a contradiction?

The differences between Trichodina and the Trichodinopsis are great. The conformation of the oral row of cilia, that of the œsophagus, the position of the nucleus, are all differential characters in addition to those of the cuticle, which conveniently separate the the two genera. On the other hand, their resemblance is undeniable. It strikes the eye at the first glance, as it relates to the general form of the body and the sucker of the posterior extremity.

But while the resemblance is confined to superficial characters, the divergences result from profound differences in organization. Even after the deep researches of Prof. H. James Clark, which tend to separate still further the Trichodina from the Vorticellians, I find their affinities greater than those between Trichodina and Trichodinopsis. If it were not for the presence of the organ of fixation and locomotion, no one would think of associating Trichodina with Trichodinopsis. Doubtless it would be said that the presence of this organ in the two cases justifies their approximation. But have we not here one of those remarkable superficial resemblances which Mr. Wallace, Mr. Bates, and others,

* Translated from M. Claparède's paper in the "Annales des Sciences Naturelles," for which we have to thank the Author.

have made us acquainted with under the name of mimetic or mocking species?

The discovery of ciliated Infusoria entirely different from Trichodina and Trichodinopsis, but, like them, furnished with an adhesive sucker, singularly corroborates this opinion. These creatures, to which I have given the generic name Lichnophora, or Fan-carriers, are not, however, quite new. Cohn had already noticed one species —doubtless identical with one which I describe below—during a visit to Heligoland, and described it *Trichodina Auerbachii*.

The two species of Lichnophora which I met with are from 0·05mm. to 0·06mm. long. I found them in Naples. One of them lived in great abundance on *Thysanozoon tubercula* (*Planaria tuberculata*, Della Chiaje, *Thysanozoon Diessingii*, Grube), the other inhabited the branchiæ of *Psygmobranchus protensus*, Phil. The first is, without doubt, identical with the *Trichodina Auerbachii*, Cohn, which the Prussian naturalist saw on a doris in Heligoland. This must, therefore, be known as *Lichnophora Auerbachii*. The second one I shall call *Lichnophora Cohnii*.

The resemblance between Lichnophora and Trichodina is so strong at first sight, that the confusion of the two, in spite of their essential differences, is very intelligible. I was at first deceived as well as M. Cohn. The body is composed of two fleshy portions—one the body, properly so called, and the other the anchoring sucker, united to each other by a sort of peduncle more or less compressed. The anchoring sucker turns its concavity towards the surface of the body of the part on which the Lichnophora lives as a parasite. It is to this fact chiefly and almost exclusively that the resemblance to Trichodina is referable; but the resemblance is only superficial. The sucker, Fig. 1, *b*, is bordered by a circular fleshy curtain, from which springs a very delicate membraneous ring, the laciniated border of which is prolonged into a circle of long vibratile cilia. The undulations by which the Lichnophora moves extend from the membrane to the cilia which form its continuation. The membraneous ring and wreath are not distinct like those of Trichodina. There is no trace of that characteristic solid ring which forms, so to speak, the skeleton of the organ of fixation of the Trichodines, Urceolarians, and Trichodinopsis.

The anterior part of the body is very difficult to study. It oscillates in different directions on its fleshy peduncle, and it is in vain to try to fix the creature by any chemical or mechanical means; for at the slightest lesion it suffers diffluence with lightning-like rapidity, and nothing but a chaotic mass of granules remains

under the eye of the observer. The anterior region, variable in form, is in general ovoid and truncated by a more or less flattened or concave peristome. Here the analogy with the Trichodines completely vanishes. Among these Infusoria, as among the Vorticellians, the peristome bears a row of mouth cilia, which make a right-handed spiral, the cilia striking in a direction opposite to that

Fig. 1.

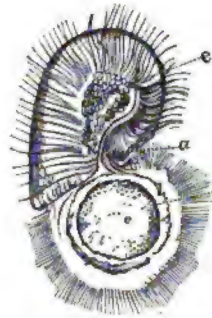


Fig. 3.

Fig. 6.

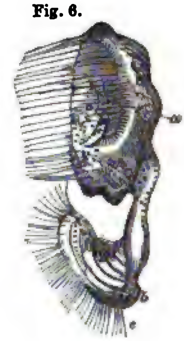


Fig. 5.

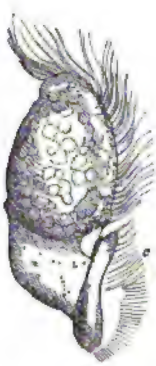


Fig. 4.

Fig. 7.

Fig. 2.

of the hands of a watch. Here, on the contrary, the curve is left-handed, and the ciliary movement is like that of the watch hands. In the *Lichnophora Auerbachii,* the form of the peristome has scarcely any resemblance to the peristome of the Trichodines. At those rare moments when the animal turns its ventral face towards the observer, it is easy to see that the peristome is piriform, or rather rod-shaped (*virgulaire*) Fig. 1, *e*. The mouth, Fig. 1, *a*, Fig.

2, *a*, exhibits itself under the form of a slit, bent towards the left margin. The œsophagus is wanting, or of extreme shortness.

The *Lichnophora Cohnii*, Fig. 6, has a much larger peristome than *Auerbachii*. The shape appeared to me almost circular. I am not quite sure of the form of the buccal opening. Its peduncle is much more flattened, and ornamented with transverse arched rays, with their concavity turned towards the top. Perhaps it would be convenient to regard these two forms as varieties of the same species.

The fleshy peduncle does not at all resemble that of the Vorticellids. It is capable of being curved in opposite directions; but exhibits nothing like a muscle. Food does not penetrate into its interior.

This description is very incomplete. The reader will learn from it nothing about the nucleus, or contractile vesicle, notwithstanding I took some pains to discover them. One fact has been acquired for science: the Lichnophora are what the English call a mocking form of Trichodina; but they can scarcely be united to the family of Urceolarians. Their peristome reminds us more of that of certain Stylonichians, that is to say, of hypotrichal Infusoria, rather of the peritrichal forms. The sucker is an organ we meet with amongst epizootic Infusoria of very variable organization.

DESCRIPTION OF FIGURES.

Fig. 1.—*Lichnophora Auerbachii*, ventral surface.
Fig. 2. ,, ,, right hand and ventral view.
Fig. 3. ,, ,, ,, and oblique.
Fig. 4. ,, ,, right side.
Fig. 5. ,, ,, front view; the peristome brought against the sucker.
Fig. 6.—*L. Cohnii* seen obliquely on the right side; *a*, mouth, *b*, sucker, *c*, ciliary membrane.
Fig. 7. ,, ,, front view.

ASTRONOMICAL NOTES FOR JULY.

BY W. T. LYNN, B.A., F.R.A.S.

Of the Royal Observatory, Greenwich.

MERCURY, being in inferior conjunction with the Sun on the morning of the 14th, will not be well situated for observation in any part of the month of July.

VENUS is also in inferior conjunction with the Sun on the afternoon of the 16th. She will therefore gradually cease to be visible in the evenings; setting, on the first day of the month, at 9h. 14m., or a little less than an hour after the Sun, and, on the twelfth day, at 8h. 11m., or just at sunset. Her place at the beginning of the month is in the constellation Cancer.

MARS rises by the end of the month shortly after midnight. In the autumn he will become extremely well situated for observation, which he will well repay. We shall recur to this when the proper time arrives.

JUPITER becomes now a conspicuous object late in the evening. At the beginning of the month he rises about half-past 11 o'clock, at the end of it a little before 10. He will be, throughout, within two or three degrees (nearly to the south) of ϵ Piscium, a star of the fourth magnitude. On the morning of the 12th he is in conjunction with the Moon, then approaching her last quarter.

The appearance of Jupiter and his belts is familiar to all who are in the habit of using a telescope. With a general similarity, being always arranged more or less completely in streaks parallel to the planet's equator, they are subject to considerable changes, taking place with more or less rapidity. There is little doubt that they are in fact tracts of clear sky produced in the atmosphere of Jupiter by currents similar to those which cause the trade winds in our own. Their greater steadiness is due to the greater velocity of Jupiter's axial rotation, which is accomplished, as is well known, in the short space of about 9h. 55m. 30s. Our knowledge of this is derived from the motions of spots, which first led to a result of this kind in the hands of Cassini, *anno* 1665. The more usual colour of these spots is very dark; but much more recently some remarkable white or luminous spots, very small in size, have been seen. They were first observed by Dawes in 1849, and afterwards by Lassell in 1850; but are out of the reach of ordinary telescopes. All the phenomena appear to indicate an atmosphere in Jupiter of some considerable density.

We have this month to mention a few phenomena of Jupiter's satellites, which are frequently both interesting and useful. We

only, however, give those, in accordance with our usual plan, which occur within a short time of midnight. It is necessary to warn intending observers that the times given for the third, and still more of the fourth satellite, may be several minutes in error, their tables requiring considerable improvement. It is desirable, therefore, in observing them, to begin to look nearly ten minutes before the time assigned in the Nautical Almanac; but the times for the first and second satellite will usually be found to agree closely with observation. In observing a transit (that is, the beginning or end of the passage of a satellite in front of Jupiter), or an occultation, (that is, the beginning or end of the passage of a satellite behind Jupiter), the times of both the internal and external contacts of the planet and satellite, and also when the limb of the former appears to bisect the satellite, should, if possible, be recorded. But with all care it is difficult to determine the time of ingress or egress nearer than about half a minute even with a good telescope, without which such an observation can scarcely be made satisfactorily at all. The immersion of a satellite in the shadow of the planet (in the following table called its Eclipse—disappearance), and the emersion of a satellite out of the shadow (Eclipse—reappearance), may, however, be observed to a much greater degree of accuracy and with comparatively inferior instruments. As the shadow gives no evidence of its existence in the sky, it is, of course, necessary to know the approximate distance from Jupiter at which the disappearance or reappearance will take place. These are given for the cases which occur, at the end of the table.

DATE.	SATELLITE.	PHENOMENON.	MEAN TIME.
			h. m.
July 5......	III.........	Occultation, disappearance ...	12 35
„ 6......	II.........	Occultation, reappearance......	12 23
„ 13......	II.........	Eclipse, reappearance	12 11
„ 13......	II.........	Occultation, disappearance ...	12 28
„ 16......	I.........	Eclipse, disappearance	12 14
„ 20......	II.........	Eclipse, disappearance	12 16
„ 22......	II.........	Transit, egress	11 37
„ 24......	I.........	Transit, ingress	12 47
„ 25......	I.........	Occultation, reappearance......	12 8
„ 29......	II.........	Transit, ingress	11 38

The second satellite will, at the eclipse on July 20, disappear about one diameter of Jupiter to the left of the planet, as seen in an inverting telescope, and reappear after the eclipse on July 13, within a very small distance of him, also on the left side; the first satellite will disappear in the shadow on July 16, about half a diameter of the planet distant from him—of course on the same side to which the shadow is directed before opposition. At that time the reappearance of this satellite is never visible, as it takes place when the satellite is behind Jupiter.

The relative appearances and colours of the satellites at different times are well worthy of observation, as they are subject to various changes of appearance and fluctuations of brightness. From these it has been concluded that, like our Moon, they always present the same face to their primary. And, notwithstanding bold assertions made in some quarters to the contrary, we must maintain that this, if established, proves that they, *like her*, have axial rotations, the times of which are equal to those of their sidereal revolutions around him. These times are 1·8, 3·6, 7·2, and 16·7 days respectively. The third satellite is considerably the largest, and is, usually, the brightest. It has been a good deal discussed whether Jupiter's moons are visible to the naked eye. This is not usually the case, but there appear to be authentic instances of their having been so seen, especially when several satellites have been on the same side of Jupiter, and near together.

The planet SATURN continues to be visible during the whole evening throughout the month of July. At the commencement of it, he sets about half-past one in the morning; by the end of it, a little before midnight. In configuration, he will form nearly an isosceles triangle with β Scorpii and λ Libræ, stars of the second and fourth magnitudes respectively, being less than two degrees to the north of a line connecting them. He will be in conjunction with the Moon on the morning of the 28th, she being then a little past her first quarter.

OCCULTATIONS.—We have to call attention this month to one occultation only of a star by the Moon—that of the bright star Aldebaran early in the afternoon of July 16. The times of disappearance and reappearance are 2h. 29m. and 2h. 51m.; the angles from the vertex at each (reckoned, as usual, to the right in an inverting telescope) 202° and 249° respectively. As the Moon does not set until twenty-four minutes past four, and the star is well adapted for visibility in daylight, the observation may probably be made without much difficulty by the aid of an instrument of

good power, and will well repay the attempt if the weather is favourable.

ENCKE'S COMET.—Throughout this month, this small but interesting body will be approaching both the Sun and Earth. On July 1st, it will be distant from us by exactly twice the distance of the Sun; on July 31st, by only one and a half times that distance. Until the middle of the month, its place in the heavens will be in the constellation Taurus; in the latter part of it, in Auriga. During the whole time, it will not rise until shortly after midnight; nevertheless we proceed to give a few approximate places of it, according to the calculations of Becker and von Asten, here reduced to Greenwich midnight.

DATE.			RIGHT ASCENSION.			NORTH POLAR DISTANCE.	
	d.	h.	h.	m.	s.	°	′
July	1	12	3	17	26	64	2
„	6	12	3	34	5	62	50
„	11	12	3	5	27	61	40
„	16	12	4	1	47	60	33
„	21	12	4	3	26	59	35
„	26	12	5	1	44	58	46
„	31	12	5	29	0	58	14

BRORSEN'S COMET.—We have a few words again to say with regard to this little comet also, but they are exclusively of an historical nature, as further observation of it during this return is now out of the question. It appears that Professor Bruhns was *not* the first person to detect the comet at the late appearance, as we stated last month. Schmidt at Athens and Tempel at Marseilles, both saw and observed it on April 11th, one day before Bruhns. Tempel believes, indeed, that he *saw* it as early as March 22, but was not able to obtain even an approximate position of it until the 11th of the following month. These facts he communicated in a letter to Professor Bruhns.* Schmidt, the indefatigable Director of the Observatory at Athens, obtained a series of equatoreal observations of the comet, commencing on April 11, and Bruhns, with the aid of his assistants, Engelmann and Vögel, also obtained one at Leipzig, commencing on April 12. It was

* "Astronomische Nachrichten," No. 1692.

afterwards observed at various places, both in England and on the continent, and results arrived at which are not yet fully made known.

The observations of Professor D'Arrest, however, at Copenhagen, possess some points of especial interest, particularly as he observed the comet also at both its previous appearances, in the years 1846 and 1857. He has succeeded in obtaining a good series, commencing on the 2nd of May (the weather previously having been unfavourable), and we here translate part of his remarks from No. 1697 of the "Astronomische Nachrichten." In a letter dated May 14th, he says: "The very strong condensation towards the centre, and the three or four bright points, which, in the want of a proper nucleus, have now, as is believed, been seen around the centre in the first month after the perihelion passage, are in good agreement with our remarks on former occasions concerning this comet; as is also the very small tail-like lengthening which has been thought to have been noticed in the comet-seeker. In the refractor, as at the preceding appearances, neither tail nor proper nucleus have been visible. The total brightness of the centre I found on May 2, 1868, to be equal to a star of the 8-9th magnitude, and on May 13th scarcely any decrease in this was to be perceived. I have not the impression that any diminution in the amount of light given by this comet can be proved to have taken place during the few years which have elapsed since 1846. In the year 1857, I was surprised at its unexpectedly great brightness; at the time when it was most conspicuous, its centre was comparable to a star of the 6-7th magnitude. It was easily visible even with small instruments in strong twilight and whilst the Moon was full. Nay, Schmidt thought that he saw it repeatedly with the naked eye between the 8th and 20th of April. This year the comet has not indeed at any time attained nearly the same degree of brightness; but the intensity would really be somewhat less, on account of the greater distance, than in the middle of April, 1857. During the next few weeks it will be very interesting to watch the remarkably rapid diminution of the comet's brightness, which astonished us in 1846 and 1857, and which will begin to be perceptible at the beginning of June. According to the experiences obtained at former appearances, I can scarcely consider it probable that it will be possible anywhere to follow it up to the beginning of the month of August."

In a subsequent letter, dated May 23rd, D'Arrest says that the diminution in the amount of light was then already perceptible, whilst the apparent size had evidently increased. On the 17th, he observed it occulting a star of the seventh magnitude. The ap-

pearance presented by the comet and star was similar to that of a very fine nebulous star of the fourth class.

New Planet.—A 98th small planet was discovered by C. H. F. Peters, at Hamilton College, Clinton, U.S., on the 18th of April. It has received the name of Ianthe.

The Moon.—On the 1st of the month, Copernicus and its neighbouring ranges may still be viewed with advantage, as the terminator will not have long passed over it. The Sinus Iridum, a level plain surrounded by abrupt and colossal cliffs, will also be well viewed near the Moon's north point. On the other side, the green Mare Humorum may be studied on the 2nd day, and the remarkable plain called Schickard on the 3rd. The Moon will be full at 8h. 39m. on the evening of the 4th. We would call attention to the row of craters which may be seen on the retreating terminator about the 6th. Commencing with near the western limb, and proceeding southerly, they are known as Langrenus, Vendelinus, Petavius, and Furnerius. Petavius, particularly, is a remarkably fine object. The Moon is in her last quarter on the 12th, 40 minutes after midnight, and new at 9h. 56m. on the evening of the 19th. About the 22nd the row of craters last mentioned may be again observed. On the 24th the lofty range Mount Taurus and the adjacent objects, particularly Mount Argæus (so named by Mr. Webb from that proximity), will be in view. The objects of the Mare Serenitatis call for examination about the 25th. The next day the Moon is in her first quarter at 1h. 52m. in the afternoon. For the 27th, we would call attention to the remarkable craters Clavius and Maginus, near the north point. Copernicus will be well viewed about the 29th. Euler, Helicon, etc., nearer the north point on the 30th. The same day, the well-known and brilliant crater, Archimedes, will be on the terminator.

We may conclude with the remark that July is not a month adapted for the observation of faint objects, or that is likely to be very fruitful in results for astronomy. The "empire of the night" is both short and doubtful. Nevertheless, there is always work to be done in a science of so large extent, and persevering devotion to particular points under various circumstances seldom fails to accomplish something of value. We would call the attention of observers of solar spots, and of the Sun generally, to the desirability of observing within two or three hours, if possible, of sunrise. But we fear that at this time of the year but few will care to undertake this. Those who do will find the definitions greatly superior to what they are later in the day.

PROGRESS OF INVENTION.

A METHOD OF MAKING SUGAR OUT OF JUICES, SYRUPS, AND MOLASSES.—The principle of this invention has been known for a long time, but its application and modification by M. le Play, of Paris, seems to be new and very promising. Sugar is precipitated as an insoluble compound of lime, and then set free. Instead of using barium, which is a very poisonous substance, M. le Play employs lime (the common hydrate). He first adds this to the liquid to be treated; he then adds chloride of calcium, and caustic potash, or soda. The precipitated sugar compound, containing sugar and lime, after being washed with water, is decomposed by carbonic acid, obtained in the preparation of the chloride of calcium, and by heating common chalk. If this last process is effected in a closed vessel, no stirring will be required. This method can be applied as well to the juice of beetroot as to syrups and molasses. Syrups, for instance, are treated as follows:—They are first diluted with an equal quantity of water, and then saturated with lime, the lime being in excess: this excess being a proof of saturation, causes a better precipitate of sugar with lime afterwards. Water is then added, and chloride of calcium in lumps or in solution; it must be stirred and heated. After the temperature has been raised to 100° C., caustic potash is added to the solution, which is stirred till it begins to boil. The precipitate is then formed, and, after being washed with water, it is decomposed with carbonic acid. Sugar can be obtained from the solution, and the mother liquid can be again treated in a similar manner for the recovery of more sugar. M. le Play says that the uncrystallizable sugar in molasses is destroyed by this method of treating with lime.

HIGH PRESSURE CALORIC MACHINE.—The various forms in which caloric machines have been produced have received an addition, in one invented by Richard Unger; it is one which well deserves attention. This machine, from its construction, does not require to be so large as those in general use; and by it, the difficulties hitherto arising from the high temperature required, are avoided. Charcoal is burned in a closed stove under a pressure of five atmospheres. The air required for its combustion is supplied by a pressure pump, worked by the machine. To the gases produced by the combustion of the charcoal, a quantity of air is brought at a temperature of about 30° C., by means of the above mentioned pressure pump; in this way a gas mixture is obtained of a temperature of from 250° C. to 300° C., which is the air used for working the machine. The engine drives a small water pump besides the pressure pump, the water from which serves to cool the air during its compression, and in this lies the special success of the machine; for by syringing cold water, in a fine spray, on the compression cylinder, it is possible to keep the air at a low temperature of about 30° C., which afterwards

becomes heated to 250° C., or 200° C., by mixing with the gases formed in the chamber where the charcoal is burnt, and so becomes considerably increased in volume, and in consequence acquires a corresponding amount of power for working the cylinder of the machine.

OPTICAL GLASSES.—Lead thallium glass has lately been made by melting 300 parts of pure sand, 200 parts of red lead, and 335 parts of carbonate of thallium (instead of 100 parts of carbonate of potash); it has a yellowish tint, a specific gravity of 4·235, and its index of refraction is 1·71.

CASTORS FOR FURNITURE.—The great defect under which the ordinary castors for furniture labour is that the axes of the wheels project beyond the legs of the tables or chairs to which they are attached, and by this means great strength is lost. Mr. Raymond Fletcher has, however, invented a castor which is not liable to this objection, and which has, moreover, the advantage of being ornamental. His invention consists of a spherical brass cup, the upper part of which is flanged, so that it can be screwed to a metal plate which is permanently fastened to the piece of furniture. A ball is made to play within this cup, the ball, of course, being smaller than the cup, so that it can move easily within it. The cup is not so deep as the ball, so that when it is screwed to the metal plate, the ball projects below it, and this ball acts as the support of the furniture, for it rests on the ground. Above the ball there are metal rollers working on axes, and these touch the upper surface of the ball, and allow it to revolve freely in all directions, they being so placed that their axes form an equilateral triangle. These bearing rollers may be either fitted to the cup on its inside or to the bearing-plate. Balls can be used instead of rollers. As a further improvement, the cup and bearing-plate can be made in one, the ball being put into the cup through an opening closed by an annular plate or ring for keeping the ball in position.

MANUFACTURE OF SULPHURIC ACID.—Some important improvements in the manufacture of sulphuric acid have been patented in France. The principal recommendation of this patent is that all large leaden chambers are dispensed with. The sulphur or pyrites is burned in compressed air, and the sulphurous acid formed by this combustion is first purified from arsenic before it is brought into contact with nitrous acid. The chambers in which the oxidation of the sulphurous acid is effected are constructed in a very convenient and suitable manner.

A NEW METHOD OF TREATING CAOUTCHOUC AND OTHER GUMS.—Sulphur is boiled in turpentine or some similar oil, a solid residue remains, the oil is poured off from the precipitate, which is washed with dilute sulphuric acid, and dried at a low temperature. Iodine is then treated in a similar manner to the sulphur, sulphuric acid being added to prevent the formation of explosive compounds. The caoutchouc is then thoroughly incorporated with a mixture formed of equal parts of the sulphur and iodine

compounds, in the proportion of about three ounces of the composition to one pound of the gum, which can then be moulded into any desired form, after which it is to be placed in an oven and kept at a temperature which is gradually increased to 320° Fah., this temperature is to be maintained for five minutes, and is then to be quickly lowered to 250° Fah., at which it is to remain for about an hour or until the composition is hard. The substance can be tinted to any colour with earthy or mineral colours which are not changed by the hardening process. The product thus obtained is hard, tough, and durable, it is not affected by acids, and is applicable to many useful and ornamental purposes. Another method of treating india-rubber or gutta-percha consists in its immersion in bromine. After the gum is moulded or carved, it is placed in bromine, and kept there until, after exposure to the air, it becomes hard. By this process the character of the gum becomes changed; but in order to prevent it from hardening before it is taken out of the bromine, chloroform, or some other solvent, may be added to the bromine in the proportion of nine parts of the latter to one of chloroform. India-rubber or gutta-percha can be dissolved in this mixture, and the solution can be applied in successive layers to a mould on which any article is to be formed; or it can be applied as a coating to other materials, the gum hardening on the evaporation of the chloroform. The patentees of this invention are Messrs. J. B. Newbrough and E. Fagan, of New York.

SECURING WATCH-CHAINS.—Messrs. William James and William Hill, of Birmingham, have patented the following invention for securing watch-chains. The invention consists of a metal plate, on one side of which is a hook-like shank; to the front side a ring is attached, either split or not, to which the chain is fastened. A hole is made in the waistcoat or other garment, through which the hook-like shank is passed; a plate of metal is then placed on the other side of the garment, and through a hole or slot in this plate the hook-like shank is passed; it is kept secure in this position by means of a small bent spring working on a pin at one end of it, which, when passed through the hook-like shank, holds the front plate in the desired position.

OBTAINING CHEMICAL COMPOUNDS.—To obtain chlorine, soda, potash, and phosphorus—and their compounds—in an improved and economical manner, Mr. James Anderson, of New Buildings, Londonderry, applies a very high temperature to the materials containing the substances required, in the presence of other substances necessary to bring about the reactions desired. This high temperature is applied by passing through the materials a gas, such as carbonic oxide or nitrogen, which contains no free oxygen. In one modification of this invention, there are introduced into a furnace, like a blast or smelting furnace, silica, alumina, or minerals, or rock containing them, such as flint, quartz, felspar, cryolite, gneiss, and the like, preference being given to those containing soda and potash. The minerals are to be broken small, so as to allow gases to pass through

them, and so as to expose a large surface to the action of these gases. A mixture of air and steam heated to a very high temperature by means of a regenerative furnace or other furnace, capable of giving the necessary heat, having first been passed over chloride of sodium or potassium, which it volatilizes and carries along with it, is made to enter the lower part of the furnace, and then to pass through the minerals. As the minerals become heated the chloride is decomposed, the sodium and potassium combining with the silica and alumina to form silicates or aluminates of sodium or potassium, which melt and flow out at the bottom of the furnace, whilst chlorine, steam, and nitrogen pass out at the top. The steam is condensed, and the chlorine may be separated from the nitrogen by absorption by lime; the silicates and aluminates are mixed with chalk, lime, or baryta as they flow out from the furnace. Hydrochloric acid may be obtained, if required, by passing through heated steam alone, instead of the mixed steam and air. The silicates and aluminates obtained in this manner are introduced into another similar furnace along with carbon, in the form of, for example, coal, coke, or charcoal; and a current of very highly-heated gas is made to enter at the lower part of the furnace, and to pass up through the materials. When the alkaline metals are required, the gas employed is carbonic oxide, or a similar gas; and when the materials obtain a sufficiently high temperature from the gas, they melt and percolate through the infusible charcoal. The alkaline earths replace the alkalies, and these being liberated are reduced by the carbon, and pass off in a volatile state, by an aperture or passage in the side of the furnace, along with the carbonic oxide formed and the heated gas introduced. When a cyanide is required, nitrogen is introduced into the furnace, and combines with the reduced alkaline metal and carbon, forming a cyanide of sodium or potassium, which passes off along with the carbonic oxide. When it is desired to get a phosphide, a phosphate such as tricalcic phosphate is introduced at the top of the furnace along with the other materials, and heated carbonic oxide is introduced below. The lime of the phosphate unites with the silica and alumina, and the trihydric phosphate liberated is reduced by the carbon at a high temperature, thus forming phosphorus and carbonic oxide, which pass off by a passage at the side of the furnace along with the alkaline metals, the phosphorus combining with them to form phosphides. Air may be used instead of pure carbonic oxide, provided that its oxygen be previously converted into that gas by well-known means, and when the formation of cyanides by the nitrogen of the air is not objectionable. When phosphorus is required, silica, alumina, and phosphate of lime are put into the furnace at the top along with carbon, and heated carbonic oxide is introduced at the bottom. The lime combines with the silica and alumina, and the phosphoric acid liberated is reduced by the carbon, and the phosphorus passes off along with the carbonic oxide and other gases introduced.

Separating Yeast from Liquid Matters.—This process consists in the employment of centrifugal force. A circular box is made, the periphery of which is made of wire gauze; within it is placed a linen or cloth bag containing the yeast, the box is made to revolve rapidly, and in this manner the moisture is thrown off.

Box-irons.—Mr. John Whitehouse has invented a box-iron in which the opening is at the top; a lid is hinged to the front part of the iron case which holds the heater; the handle is, as usual, of wood; a metal guard is placed between it and the iron to protect the hand from the heat; to the heater an iron wire loop is fastened, by which it can be removed from the box; and its bottom surface is indented so that it only comes in contact with the box in places, and thus the heat is better regulated; and not radiating so rapidly, the conduction to the outer surface being less perfect, the iron will remain hot for a longer time.

Combined Muff and Bag.—A very convenient, secure, and not unsightly arrangement has just been brought out and patented by Moritz Vogl and Heiman Van Dyk. It consists of a frame with an upper and under part; the frame is curved to the shape of the muff, and is made of metal; it opens outwards somewhat like a purse. The fastening, or catch, which is attached to the upper part of the front frame, passes through the back part of the frame, and can be fastened or released inside the muff; and to it a lock can be attached, if desired. A spring is fixed between the front and back part of the frame, which causes it to fly open when the catch is released from the inside of the muff; and when it is desired to close the bag, it can be done by pressure from without. By properly arranging the hair of the muff, the bag may be entirely concealed.

LITERARY NOTICES.

Reliquiæ Aquitanicæ; Being Contributions to the Archæology and Palæontology of Perigord, and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Edited by Thomas Rupert Jones, Professor of Geology, etc., Royal Military College, Sandhurst. Part V. (Baillière.)—In the fifth part of this splendid work, Professor Rupert Jones concludes a sketch of the geology of the Vezère, and then follows an interesting letter from Mr. Alex. C. Anderson, of Vancouver's Island, showing the similarity of some of the implements found in Dordogne to those used by the North American Indians, and instituting comparisons between the cave dwellers and the ancient Germani, as described by Cæsar and Tacitus. Mr. Anderson makes the following observations on the reindeer, which may tend to correct some common misapprehensions.

"Reindeer have never, in America, been herded in a domestic state, as is done by the Laplanders and others of Northern Europe; nor are they by the natives employed as beasts of draught. They exist only in their wild and natural condition. . . . . So with the Germans, and so, inferentially, with the people of ancient Aquitania; for there is nothing to authorize the supposition that they (the Germans) *tamed* the reindeer for domestic purposes, but only hunted it. . . . . Indeed, I very much question whether the Laps, Fins, etc., *domesticated* the reindeer until a comparatively late date. . . . Any theory, therefore, that might be based upon the disappearance of the reindeer from southern latitudes, in connection with the migration northward in remote ages of the past of the Esquimaux and other northern tribes, ought, I submit, to be very cautiously entertained."

The part before us is illustrated with four plates representing varieties of flint implements, and two landscape views of the site of caverns, explored by Messrs. Lartet and Christy, one representing Le Moustier on the Vezères, and the other the village of Les Eyzies.

It is impossible to do justice to a work of this kind until it is completed, but there can be no doubt from the five parts now before the public, that it will be a record of great interest in a scientific point of view, and will be highly gratifying to the friends of the late Henry Christy as a noble monument of his intelligence and zeal.

Ovid, Selections for the Use of Schools, with Introduction and Notes, and an Appendix on the Roman Calendar. By William Ramsay, M.A., formerly Professor of Humanity in the University of Glasgow, Author of "Manual of Roman Antiquities," etc. Edited by George G. Ramsay, M.A., Trin. Coll., Oxon, Professor of Humanity in the University of Glasgow. (Oxford, Clarendon Press.)—This is an elegantly printed book of 352 pages, of which seventy-four are occupied with judicious selections from the poet, and the remainder with valuable and scholarlike notes, which will be found of much use to students, as they range over a great variety of topics, critical, philological, historical, mythological, etc.

Every Man's Own Lawyer; a Handy Book of the Principles of Law and Equity, comprising the Rights and Wrongs of Individuals. By a Barrister. Sixth Edition, carefully revised. (Lockwood and Co.)—This is a very useful work, which ought to find its way into all family libraries, merchants' counting-houses, etc. It is a compendious epitome of laws affecting the relations and transactions of ordinary life. It is well printed, of a handy size, and convenient for reference. The fact of this work having gone through five editions is evidence of its adaptability to general wants, and although we cannot endorse the promise on its cover, of "no more lawyer's bills," we very strongly recommend it as a serviceable guide, and frequent substitute for consultations.

First Lessons in Astronomy in Question and Answer. Seventh

Edition, revised. (Jackson, Walford, and Hodder.)—We cannot recommend this Catechism, as sufficient care has not been taken in re-editing it, and we do not think very highly of the catechism form of communicating knowledge. At page 8 is a curious mistake, that at seventy miles an hour it would take forty thousand years to go round the sun's circumference, which is given at 2,764,600 miles. In the chapter on the telescope it is erroneously stated that all the nebula examined by Lord Rosse's telescope have been resolved into stars, and that all nebula are star clusters. It is also absurd to represent our knowledge of the moon as having been materially effected by Lord Rosse's instrument, as all the principal moon work has been done with other instruments; nor is it right to assert that the whole surface of our satellite presents the appearance of a prodigious cinder, or a world entirely consumed by volcanic fires. Some folks have had such fancies, but they may be a long way from facts. The real constitution of the moon is still open to much doubt.

Instructions in Wood Carving for Amateurs, with Hints on Design. By a Lady. (Lockwood and Co.)—This is an elegant little book, which we hope will induce many of our readers to follow the good example of its authoress, and learn an art of much value and well adapted to female skill. In the present day, when in too many well-to-do families girls who have left school, pass their time in unprofitable idleness, it is well to find recreations springing up which tend to cultivate taste, and make the principles of design familiarly understood. With a little pains and patience ornaments of great beauty may be made upon the hints given in this book, and the knowledge gained will greatly facilitate the appreciation of the higher branches of design, as exhibited in architecture and art manufactures.

A Treatise on the Action of Vis Inertia in the Ocean; with Remarks on the Abstract Nature of the Forces of Vis Inertiæ and Gravitation, and a New Theory of the Tides. By Wm. Leighton Jordan, F.R.G.S. (Longmans).—We are afraid this must be catalogued amongst the long list of mistaken works, such as those which endeavour to demonstrate that the earth is a prolate, not an oblate, spheroid; that the orbits of celestial bodies are perfectly circular, etc., etc. Mr. Jordan considers that as the earth rotates, the vis inertiæ of the waters of the ocean give them a permanent tendency to a relative movement in an opposite direction. He seems to regard currents and tides as resulting from the conflict of terrestrial rotation with vis inertiæ; but we do not profess to understand his explanation. Perhaps our readers may succeed with such sentences as the following:—"As the earth moves, the force of gravitation, which is the act by which vis inertiæ resists that motion, is then created by the pre-existing force of vis inertiæ, simultaneously with the creation of the motion which vis inertiæ resists." Or, "In two volumes, published in 1866 and 1867, I have endeavoured to show that

not only the ocean, but also the outer crust of the earth and the atmosphere, all bear evidence of the action of vis inertiæ upon them; and if this be shown to be the case, we shall then have made the first inductive step towards a knowledge of the cause of the motions of the earth. For, if it be shown that those parts of the earth are acted upon by vis inertiæ, it must then be admitted, as a necessary corollary, that the forces which move the earth act chiefly upon it in its interior parts, so that the outer crust of the earth, as well as the ocean and air, being comparatively dead to the influences which cause motion, are acted upon by vis inertiæ as they are carried along upon matter in the interior part of the earth, which must be either comparatively alive to influences from without which set it in motion, or, otherwise, must move by virtue of an inherent property of motion which the exterior parts of the earth do not possess."

OM EN MÄRKLIG I NORDSJÖN LEFVANDE ART AF SPONGIA. Ap S. Lovén. This is a paper from the Transactions of the Stockholm Academy, describing a small but very interesting species of siliceous sponge of the genus Hyalonema. Our readers will recollect Professor Wyville Thomson's paper on the *H. Sieboldii* in the INTELLECTUAL OBSERVER. Since then M. B. Du Bocage discovered a Portuguese species, *H. Lusitanicum*, and M. Lovén now describes "*H. boreale* n. Hab. in mari septenntrionali extras oras Norwegiæ profunditate 200 orgyarum." The paper is illustrated with engravings, representing the pear-shaped sponge supported by a column formed of a bundle of siliceous threads, showing details of structure.

RESEARCHES IN SOLAR PHYSICS. By Warren De la Rue, Esq., Ph. D., F.R.S., Pres. C.S., F.R.A.S.; Balfour Stewart, Esq., LL.D., F.H.S., F.R.A.S., Superintendent of the Kew Observatory; and Benjamin Loewy, Esq., F.R.A.S., Observer and Computer at the Kew Observatory. Appendix to Second Series, and in continuation of it. On the Distribution in Heliographic Latitude of the Sun Spots. Observed by Carrington. (Printed for private circulation by Taylor and Francis.)—In the second series of these important researches the authors observed, "it would appear that spots are nearest the equator when the heliographic latitude of Venus is 0°, and are most distant from the solar equator when this planet attains its greatest heliographic latitude." The present publication gives a mass of tabulated details to test this statement. The result is, that on the average the latitude of sun spots when Venus crosses the solar equator is less than when she is at her greatest distance therefrom; but this difference—between 16° 8′ and 17° 16′—is not as great as might have been expected from the theory of the influence of the planet; and the authors consider "more observations necessary." "At those periods for which the present method of research is particularly applicable, we get a good result; but for that period for which it is not so applicable the evidence is less satisfactory." It is to be hoped that further research will clear up this very interesting question.

NOTES AND MEMORANDA.

COURSE OF ATLANTIC STORMS TO ITALY.—M. Matteucci publishes in "Comptes Rendus" a short paper, showing that out of 118 storms coming from the Atlantic and striking the western coasts of England and Ireland, 49 reached Italy. In October, November, and December, the progress of these storms to Italy is much more frequent than at other periods; while in midwinter, and still more in summer, a striking diminution occurs. In the three months named, out of 29 storms, 23 reached Italy; in April, May, June, July, and August, out of 41, only 3 arrived at Italy.

PHOSPHORESCENCE OF THE SEA.—On the night of the 31st May, an unusually magnificent display of luminosity of the sea was witnessed at Teignmouth. A correspondent tells us that old sea-captains pronounced it the most brilliant they had ever seen. He says, "The waves broke moderately, from two to three feet high, of the most magnificent green that can be conceived—the new aniline green is nearest to it—and of such power that the light was visible against rocks two miles away." The same correspondent kindly sent us some of the luminous water, which we found full of the well-known *Noctiluca miliaris.*

ACTION OF SNAKE POISON.—Mr. S. P. Holford states in "Trans. Roy. Soc. of Victoria," that when a person is bitten by the Cobra di Capella, living germs are introduced into the blood, which multiply, so that millions of small cells are produced in a few hours, at the expense of the oxygen absorbed during respiration. He describes the cells as round, about 1—1700″ in diameter, and having round nuclei 1—2800″ in diameter, and containing germinal spherules.

CAPACITIES OF IDIOTS.—Some very interesting statistics are given in the schoolmaster's report of the state of his pupils in the Earlswood Asylum. He has 154 scholars from the inmates, and they are divided into six classes. The highest "can read in the New Testament with tolerable correctness, write sentences in copy-books, and do sums either by themselves or from the black board. The second class can read in an easy lesson-book, count above sixty, and add a little from the black board. The third class know the greater part of the alphabet, and count above thirty. The fourth class know six or seven letters, and count above twenty. The fifth can only speak vowel sounds, know one or two letters, and count to three or four. The sixth can only articulate one or two sounds, and cannot count, but will sometimes come when they are called."

STARCH IN THE YOLK OF EGG.—M. Dareste states in "Comptes Rendus" that he has succeeded in identifying with starch certain granules observable in the yolk of an egg.

THE OXYHYDROGEN LIGHT.—M. Caron states that oxide of zircon gives the most luminous effects on the oxyhydrogen flame. As it is expensive, he merely coats another material with it.

DEEP SEA DREDGING.—There is reason to hope that the government will place a suitable steamer at the dispósal of Dr. Carpenter and Professor Wyville Thomson for some important experiments in deep sea dredging, which the Royal Society has had the good sense to support. In a letter to Dr. Carpenter, Professor Wyville Thomson alludes to the success obtained by M. Sars, the Swedish naturalist and inspector of fisheries, who obtained abundant animal forms at 300 fathoms depth off the Loffoden Isles; amongst them a beautiful little crinoid, at once recognized as a degraded type of the well-known fossil Apiocrinites. Dr. Carpenter addressed General Sabine, President of the Royal Society, on the subject, pointing out that the projected expedition could not be accomplished by private means. He proposes to start from Kirkwall or Lerevick, and to explore the sea bottom between the Shetland and Faroe Isles, dredging round the shores and fiords of the latter, and then to proceed N.W. into deep water. Results of great importance to science may be anticipated if this project is carried out.

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